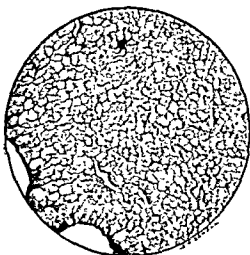
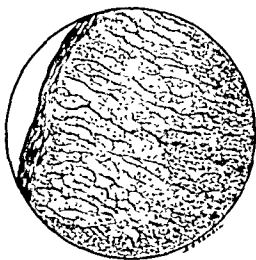


POST-GRADUATE SURGERY

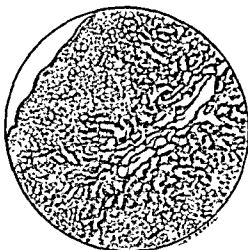
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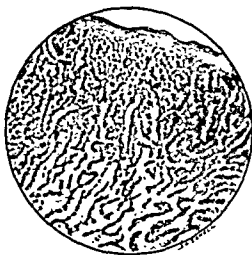
A.—ADRENAL CORTX VIRILISM. FUCHSIN
OPHIL STAIN PRESENT.



B.—NORMAL FEMALE ADRENAL FROM OVAR-
ECTOMY CASE. FUCHSINOPHIL STAIN ABSENT.



C.—FETAL ADRENAL CORTX 16 WEEKS
MALE. FUCHSINOPHIL STAIN PRESENT.



D.—FETAL ADRENAL CORTX: 15 WEEKS
FEMALE. FUCHSINOPHIL STAIN ABSENT.

POST-GRADUATE SURGERY



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SECTION 1

HEAD

CHAPTER I

HEAD INJURIES

It is a truism to say that, with the advent of the modern motor car, head injuries are becoming of increasing frequency, severity and importance. The high speeds attained by cars and motor cycles are presenting us with types of injuries previously only seen in military practice (fig. 847). It is becoming increasingly important for the surgeon to take a comprehensive view of each case under his care, owing to the multiple nature of the findings he may expect. The tendency to label cases as "concussion," "cerebral irritation," "fractured base," and then treat as per label, is now more than ever to be deprecated. Symptoms of head injuries are often latent, and lesions are frequently of a progressive nature. It is, therefore, essential for the surgeon to bear in mind the "possibilities" or "potentialities" in every case. Careful and accurate observation and frequent re-examination of these cases will often give most gratifying results, and will certainly save many lives and prevent much chronic illness. We wish again to emphasise the need for a comprehensive view, a non-parochial outlook, as, necessarily in description, headings and labels have to be used which seldom are as clear-cut in the patient. Without further preamble, therefore, we propose to proceed to :

THE GENERAL ROUTINE EXAMINATION OF A CASE OF HEAD INJURY

It may be objected that many of these points are elementary, and the examination worthy of a casualty house-surgeon. We can only state that it is the occasional lack of some simple obvious point in history or examination that has cost the patient his life or health. We may further remind critics that legal proceedings very frequently



Fig 847 - A PHOTOGRAPH OF A POST-MORTEM SPECIMEN OF A FRACTURED BASK CASE. NOTE THE MULTIPLE FRACTURES AND GENERAL SEVERITY OF THE LESION - THE RESULT OF A MOTOR CYCLE COLLISION.

follow these cases, with the medical attendant called to give evidence. Notes made *at the time* of the examination are acceptable as evidence in the witness box, and are invaluable to the busy surgeon called to give evidence, perhaps eighteen months later. The full examination, as detailed, should apply to all but the most trivial cases :

(1) *History.*

The time and nature of the accident is noted.

The question of loss of consciousness at the time of the accident, and the patient's subsequent conscious state investigated. (Behaviour in ambulance, etc.)

It is important to attempt to ascertain the approximate period of unconsciousness.

The question raised of the possibility of a lucid interval.

The occurrence noted of headache, vomiting, or fits.

Any special observations of the spectators.

(If possible, the previous health of the patient noted.)

(2) *Examination with regard to Head Injuries.*

The depth of unconsciousness (if present), or mental state and orientation (if conscious), is ascertained as carefully as possible and noted for future comparison.

The head is inspected and palpated for wounds and bruises respectively.

A neurological examination is made, more particularly to include : the cranial nerves, the tone of the limbs, the tendon reflexes, the plantar reflexes, and the state and reaction of the pupils. If conscious, the movements of the limbs and sensation may be tested.

An X-ray photograph is taken as soon as it is convenient.

In selected cases, lumbar puncture is performed and the fluid examined for blood.

(3) *General Examination.*

It is important to examine carefully for signs of injury elsewhere. The patient may be unconscious or too collapsed to indicate their likelihood. We have known of cases where fractures of other bones have been completely missed until some weeks later, and of cases where an injury to some viscus has been overlooked, with a fatal outcome. Special tests for such injuries are carried out as required.

In conclusion, we again emphasise the need for repeated examination, as changes in the clinical state may be rapid, profound, and diagnostic. In every case where the patient has been unconscious, the pulse should be recorded half-hourly for twenty-four hours, and longer if necessary. The nurse should be instructed to inform the surgeon if the pulse-rate becomes slow, vomiting is repeated frequently, the restless patient becomes comatose, or if any other striking change, not anticipated, occurs.

We now turn to a description of the "possibilities" in any case of head injury, and their treatment. It is obvious that we can only outline some of these possibilities and adhere to clear-cut clinical entities.

A blow on the head may expend its energy in damaging the integuments, the skull, or the brain, or all three or any combination of the three. The injury may be limited to the time of the accident or forces may be set in motion which are liable to produce further damage—infection, or hæmorrhage.

It is important to realise that a blow on the head may cause profound cerebral disturbance with little or no signs of external injury, while the converse is equally possible and only slightly less probable.

The force of the blow may, therefore, be expended in damage to the scalp and skull, or it may be transmitted to the brain. The usual finding, however, is that all three have been damaged in cases of direct injury.

CLINICAL FEATURES AND TREATMENT OF SOME FORMS OF INJURY TO THE INTEGUMENT

Scalp Wounds. These are noted for their excellent power of healing. It should be emphasised that only the smallest wounds are suitable for suturing in the casualty department. The larger ones should be dealt with in a full operating theatre, as exploration of the skull may prove necessary. The whole head should be shaved in any case of doubt, as it is surprising how frequently other wounds or signs of injury are found. The edges of all wounds are excised and the wounds washed out and explored. Again, it is surprising how often pieces of brick, road surface, hair-clips, tar, or other debris have been carried far into the scalp in the "dangerous layer," and would have been left in at a preliminary casualty suturing. A search is made for any fracture of the skull, and, if present, it is dealt with as described on page 1751. The wound is finally washed out and sutured, with drainage. Anti-tetanus serum is administered as a routine measure.

Avulsion of the scalp is treated by cleansing, trimming, and replacement, with suture of the avulsed portion. A good result may be anticipated in most cases.

Loss of Scalp Substance. Small losses of scalp substance may be treated by Cushing's method. The edges of deficiency are enlarged tripod fashion, and the wound sewn up in the form of a Y. Larger losses of scalp substance should be treated early by plastic measures. While Thiersch grafts take extremely well on the scalp, the resulting skin is very thin and not suitable. A pedicle graft is more satisfactory.

Hæmatoma of the Scalp. This may be subcutaneous, subaponeurotic, or sub-pericranial.

Subcutaneous Hæmatoma. The chief interest of this condition lies in its differentiation from a depressed fracture of the vault. The hæmatomata are circular with a firm rim and soft centre. The following tests serve to distinguish them from a depressed fracture :

- (a) The hard rim can be indented on steady pressure.
- (b) The whole hæmatoma can be moved very slightly on the skull.
- (c) In adults, fractures which are depressed are almost invariably compound.

An X-ray photograph will clinch the matter. These hæmatomata are best left alone. Suppuration practically never occurs.

Subaponeurotic Hæmatoma. This forms a characteristic swelling bulging round the lower scalp margins. It may communicate through a fracture with an extra-, or sub-dural hæmorrhage, forming a safety-valve leak. This is more usual in children.

Subpericranial (cephal) Hæmatoma. This is a hæmatoma limited to the area of a skull bone. It is only common in the new-born and young children. No special treatment is required.

FRACTURES OF THE SKULL

Clinical features and treatment. A fracture of the skull is of itself only of importance in so far as :

(1) It is compound and, therefore, a potential source of infection for the brain and meninges.

(2) It is depressed and, therefore, a direct source of injury to the brain.

(3) It is complicated by injury to nerves or blood-vessels, the latter causing further injury to the brain.

(4) There is extensive loss of bony substance.

(5) In doubtful cases of intra-cranial hæmorrhage, the side of the fracture may be the side of the lesion.

Apart from these points, fractures of the skull are unimportant in themselves—it is the associated cerebral injury that is important. In their uncomplicated state there is no treatment for them. They unite readily (unless there has been loss of substance), and we can do nothing to accelerate recovery. The classifications into stellate, fissured, linear varieties, etc., are not of value from the treatment aspect (fig. 848).

Two types of fracture, however, call for urgent treatment, namely : the compound fracture, and the depressed fracture. In adults, fractures of the vault are frequently compound, or at any rate associated with scalp lacerations, even if there is no direct “skin to fracture” communication.

Treatment of Compound and Depressed Fractures. The treatment is operative. In view of the recent nature of the injury the choice of anæsthetic may be delicate. Ether is not suitable, as the rise of blood-pressure it causes may start a hæmorrhage in the cranial cavity.



FIG. 582.—RADIOGRAPH SHOWING FORKED LINEAR FRACTURE IN THE VULV.

NOTE (1) THE SMALLER FRACTURE ON THE OPPOSITE SIDE.

(2) THE OBVIOUS DIFFERENCE BETWEEN A FRACTURE AND A SUTURE.

Chloroform is too depressant to the vital centres, and is dangerous. Gas and oxygen is the best general anæsthetic, but the patient must never be allowed to become cyanosed: it may be supplemented by local injections of freshly sterilised $\frac{1}{2}$ per cent novocaine with adrenalin. If the patient is unconscious a local anæsthetic is sufficient.

The whole head is shaved, cleansed, and purified. Any scalp wounds are next dealt with and excised (see page 1750). A thorough excision of the wound leading to the fracture is then made, and the integuments are irrigated and cleansed.

The next step is inspection of the fractured area. A good view is essential—the surgeon should incise the scalp further if necessary.

If the fracture is of the linear variety, and the wound clean, we advise that it should be treated by suture, with drainage. Some surgeons, however, advocate trephining in these cases, because at the time of the actual fracture some foreign substance may have been carried in, or because the inner table may be more severely damaged than appears from the outside. While not denying these possibilities we advise more conservative measures (in the absence of symptoms),¹ as it is manifestly impossible to excise whole lengths of fissured fractures on the chance that there may be some foreign inclusion.

If the fracture is depressed it must be elevated (fig. 849). Any small fragments are removed, while to elevate the larger fragments the skull is trephined through healthy bone, and through such a lever hole the depressed area elevated. In actual practice elevation in adults in compound depressed fractures is seldom necessary—it is better to remove the fragment unless it is very large. If the dura has not been torn by the injury, great care should be taken to keep it closed, thus avoiding the risk of lepto-meningitis. If, however, there are symptoms of subdural hæmorrhage, the dura should be laid open freely, and the brain inspected. If the dura is lacerated, it should be trimmed, opened



Fig 849.—DRAWING SHOWING FRACTURE WITH SOME COMMINATION AND DEPRESSION. THE CIRCLE SHOWS THE AREA TO BE TREPHINED, FROM THERE THE WHOLE FRACTURE MAY BE EXCISED OR ELEVATED AS APPEARS BEST.

¹ Or X-ray evidence of damage to the inner table.

freely, loose brain substance removed, a search made for spicules of bone, irrigation carried out, and the wound closed with drainage. It is frequently convenient to drain through a separate stab incision and to close the main incision completely.

In children, fractures of the vault are more frequently simple and



Fig. 850.—DEPRESSED FRACTURE OF THE LEFT FRONTAL REGION. THE CHILD HAD NO SYMPTOMS OF COMPRESSION. IT SHOULD BE ELEVATED IN ANY CASE.

their treatment is that of the underlying cerebral injury, whether concussion or contusion. If there are signs of local irritation, then it may be justifiable to trephine the region of the fracture. If they are depressed they should be elevated (fig. 850).

FRACTURES OF THE BASE OF THE SKULL

Fractures of the base of the skull have usually been described as though they formed a different surgical entity from fractures of the

rest of the cranium. This is untrue, and confuses any attempt to grasp the significance of an injury to the head as a whole. Fractures involving the base of the skull may, and frequently do, extend up the side of the cranium and communicate with the vault.

While, therefore, it is convenient to describe the clinical features of these fractures separately, it should be borne in mind that they do not differ in principle from fractures elsewhere. The base of the skull may be fractured indirectly by falling on the heels from a height, or by a blow on the jaw. A direct fracture may be caused by penetrating wounds of the orbit (umbrella ferrule in the eye), but, of course, by far the commonest method is a blow on the head, the force expending itself on the more rigid base of the skull. These fractures are usually irregular and run obliquely across the skull, involving one anterior cranial fossa, the opposite middle cranial fossa, and perhaps the

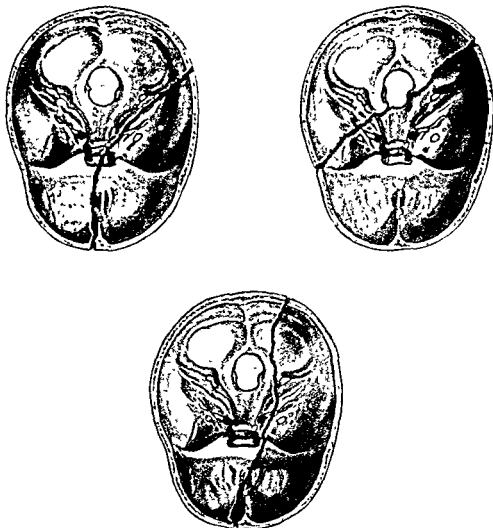


Fig. 851.—DRAWINGS SHOWING SOME OF THE DIFFERENT TYPES OF FRACTURES OF THE BASE OF THE SKULL.

The surgeon, in treating a fracture of the base of the skull, is really concerned with the actual degree of cerebral injury, or with the complications of the fracture, such as cerebro-spinal fluid escape, etc. These fractures unite well and need no treatment beyond the rest necessary for the associated cerebral disturbance. The possible sequelæ of the fracture are dealt with later. (See Pneumatocele, Cerebro-spinal Rhinorrhœa, etc.)

CLINICAL FEATURES AND TREATMENT OF INJURIES TO THE BRAIN

We have previously alluded to the unsatisfactory state of our knowledge of the pathology of cerebral damage, and we propose to confine ourselves to the clinical and therapeutic side. The issue is confused rather than clarified by a number of terms¹ (of established usage), given to the various states which may follow a cerebral injury. Some of these terms are descriptive, some pseudo-pathological, and all tend to be used vaguely and loosely. They are, however, established terms and will be used in description. It is important, therefore, to form a clear opinion as to the implication of each term.

Concussion. The simplest and commonest state which follows injury to the brain is that which is known as concussion of the brain. The best definition is that of Trotter: "Concussion is a condition of widespread paralysis of the functions of the brain, which comes on as the immediate consequence of a blow on the head, has a strong tendency to spontaneous recovery, and is not necessarily associated with any gross organic change in the brain substance." The points requiring emphasis are as follows:

(1) *The immediate onset of symptoms.* It must be clearly understood that states of unconsciousness following a head injury after an interval has elapsed, whatever else they may be due to, are not due to concussion.

(2) *The tendency to rapid and complete recovery.* This happens in an overwhelming number of cases, so much so that it is highly probable that when it does not occur, there is some factor at work which we are not as yet able to demonstrate. Thus a patient who remains unconscious for hours or perhaps one or two days after a head injury, is not suffering from a condition of concussion, but from some other

¹ Cerebral concussion, cerebral contusion, cerebral irritation, cerebral compression, cerebral œdema, etc.

condition, which may require a different outlook on the part of the surgical attendant. The golden rule, in a case which does not conform to the definition given, is to suspect some other pathology and be prepared to treat accordingly.

The Treatment of Concussion. This is purely empirical. We are treating a condition of which we have no exact pathological knowledge. The classical three weeks in bed is an excellent dictum which we completely endorse, but it needs to be understood that this is advised because we do not know what is happening. We know that after the simple state of concussion many unpleasant sequelæ may occur—persistent headache, impairment of attention, failure of memory, change of behaviour, giddiness, etc. We have found, by trial and error, that these sequelæ more commonly occur when the patient does not get a period of rest following the injury. This is one very adequate reason for insisting upon rest in bed. From this aspect we may further add that the more intellectual patient with a responsible position is more liable to develop these sequelæ and requires a longer period of rest. Another important reason for this long period of rest is the fact that we can never be certain that the condition is uncomplicated by local bruising of some area of the brain which may soften and be followed by hæmorrhage. Hence, violent exercise should be forbidden for some period after any severe head injury. The general features of the treatment, rest, quiet, attention to bowels, etc., are too well known to require mention. We wish, however, to stress the inadvisability of giving morphia to these cases. Drugs of the hypnotic class are particularly useless in allaying the symptoms of these cases, and morphia is dangerous. We are aware that house surgeons may feel that a restless, noisy patient is a nuisance to others in the ward, while the relatives will demand it for the private case, but the practitioner will have to be tactful. The best sedative is a good dose of mag. sulp., while ice may help the headache. When the patient is allowed up, any return of symptoms, such as headache, etc., calls for a return to bed. Headache persisting after rest, or during such rest, calls for a simple decompression operation. Such an operation should not be too long delayed, i.e. until the patient has become "chronic."

CEREBRAL IRRITATION

OPON is familiar with the clinical aspect of this condition.
 " in a semi-conscious condition, curled up in bed,

resentful of all stimuli, such as noises, lights, examination; incontinent of urine and faeces, sometimes with retention of urine, and noisy and wakeful at night and sometimes drowsy by day (fig. 852). There may be periods of maniacal frenzy or periods of diminution of consciousness. The mode of onset may be characteristic—following concussion the patient regains consciousness, but then complains of headache, nausea, and vertigo, and lapses into the irritable state. It is important to try to ascertain the actual level of conscious state. These patients are usually conscious, but confused—an important point in



Fig. 852.—CEREBRAL IRRITATION. THE BOY HAS A FRACTURE OF THE ANTERIOR CRANIAL FOSSA WITH A HÆMORRHAGE INTO THE ORBITAL CELLULAR TISSUES. NOTE THE DROWSY EXPRESSION.

differentiating from an intra-cranial hæmorrhage. It is, however, necessary to watch carefully for signs of intra-cranial hæmorrhage complicating this state.

The usual course in the uncomplicated condition is towards recovery, a recovery which, however, may be very liable to be attended by the residual symptoms mentioned under "Concussion." Complications such as hæmorrhage, urinary infection, or pneumonia will, of course, dominate the picture and make the prognosis very grave.

Treatment. In the management of these cases, the guiding principle is the prevention of complications. The condition is known to tend towards recovery, and the surgeon's aim is gently to assist that tendency. A great deal has been written about methods of lowering

intra-cranial tension, and a great amount of clinical investigation is being made of these methods ; investigations which are, unfortunately, often inadequately controlled. Our opinion is stated dogmatically, but we are aware that many surgeons are of a different outlook. Until the pathogenesis of the condition is better understood, and the mechanism of intra-cranial variations in pressure worked out, advance in this subject is likely to be haphazard and empirical. In our opinion, the clinical state called "cerebral irritation" (in itself a bad term) is due to a bruising of the whole surface of the brain, or a large portion thereof. This bruising leads to swelling of the brain, which is limited by its anatomical surroundings which are often bruised as well. Such a bruise has to run its normal course, and will do so unless modified by some continuously acting factor of which the most usual is continuance of pressure or the occurrence of hæmorrhage. While methods of lowering intra-cranial tension are undoubtedly effective for the time, they are of short duration, not without risk, and not always of permanent value. Their routine use is to be condemned, they should only be used when a definite indication arises. There is no well-defined middle course between rest in bed and allowing Nature to take her course, and the performance of a large decompression, thus allowing the brain to swell.

The surgeon's main aids are : rest, careful nursing, attention to the avoidance of stimuli, feeding, oral toilet, etc., and saline purge.¹ Hypnotic drugs are of little value, and sometimes appear to make the patient worse—he becomes "doped." The drastic methods of lowering the intra-cranial pressure of the cerebro-spinal fluid, such as intravenous hypertonic salines and lumbar puncture, are sometimes difficult to perform on the irritable patient without an anæsthetic, which is undesirable. They are of value in attempting to secure a night's rest for the patient or to relieve an excess of headache.

Decompression. A case that fails to respond to these measures, or one that, having responded, relapses, calls for further treatment. The surgeon should first be careful to exclude the occurrence of a hæmorrhage. Provided the case is uncomplicated, we advise a simple subtemporal decompression (see page 1764). The benefit of such an operation is surprising to those unfamiliar with these cases. The operation should not be unduly postponed, as these patients steadily deteriorate under the prolonged delirium, and are liable to succumb from pneumonia or urinary infection.

¹ Magnesium sulphate may also be given rectally.

Intra-Cranial Hæmorrhage and Cerebral Compression. An injury may cause compression of the brain in its bony case in a number of ways. Part of the skull may be driven in, a foreign body may be implanted, or the brain may be compressed by exudates or hæmorrhages. Hæmorrhage may, and frequently does, complicate any of the other methods. When, however, a fracture co-exists, it is frequently possible for the hæmorrhage to escape into the sub-aponeurotic layer of the scalp and form a pulsating swelling. Hæmorrhage may arise from the vessels of the skull bones, the blood sinuses, the meningeal vessels, and finally from the vessels of the brain. Hæmorrhage may come on immediately with the injury, or later during the course of the first week, when it may be precipitated by a sudden rise of blood-pressure (due to vomiting, straining at stool, injudicious movements, or to excesses of delirium); finally, hæmorrhage may come on some considerable time after the injury, the usual limits for this type being three weeks to one month. This delayed hæmorrhage or "*spät-apoplexie*" is a rare but definite entity. It is due to hæmorrhage from an area of cerebral softening. Intra-cranial hæmorrhage may be classified as :

- (1) Extra-dural—meningeal hæmorrhage.
- (2) Sub-dural—which may be sub-arachnoid as well in many cases :
 - (a) diffuse ; (b) localised.
- (3) Intra-cerebral :
 - (a) small ; (b) communicating with the ventricles of the brain.

Any combination of these types of hæmorrhages may be found. We may dismiss 2 (a) and 3 (b) from consideration by saying that they are usually rapidly fatal and only of pathological interest.

(1) *Extra-dural Hæmorrhage.* This is the classical "middle meningeal hæmorrhage." In comparison with other forms of intra-cranial hæmorrhage it is uncommon, but it forms a definite clinical entity. For signs and symptoms the reader is referred to any standard surgical text-book, we will only emphasise the fact that the classical signs, dilated insensible pupils, slow stertorous breathing, slow pulse, and high arterial tension, are not so much signs of this condition as signs of impending death from medullary compression and indicative of dangerous delay in treatment. (In fractures of the sub-tentorial region with hæmorrhage, these signs may appear first—this condition is very urgent.) The treatment is operative.

(2) *Localised Sub-dural Hæmorrhage.* This is commoner than middle meningeal hæmorrhage, but forms a less well-defined clinical entity. If the arachnoid mater is also damaged, then blood will leak into the cerebro-spinal spaces and spread freely. The hæmorrhage may be repeated. The signs and symptoms are similar to those of middle meningeal hæmorrhage, with this single important and distinctive exception—there is seldom a definite “lucid interval” comparable with that characterising extra-dural hæmorrhage. The treatment is operative. Sub-dural hæmorrhage may be of a chronic nature, the course of the disease lasting over weeks or even months. The original small hæmorrhage becomes encysted and then further hæmorrhages occur into the cyst wall. The clinical course of these cases is more comparable to that of a cerebral tumour than of a head injury, with the exception of the fact that remarkable periods of remission of symptoms may occur. Papillædema may occur, but is less common than in cases of cerebral tumour. The treatment is operative with removal of the cyst.

Intra-cerebral Hæmorrhage. This form of hæmorrhage, if not immediately fatal, is very likely to be followed by cyst formation. Very rarely, and only in children, these cysts may communicate with the lateral ventricle. These traumatic cysts give rise to symptoms exactly comparable to those of the sub-dural cysts just discussed, and their treatment is the same.

In general, it should be noted that it is far more important to diagnose *the fact of the occurrence* of an intra-cranial hæmorrhage than to diagnose *its type*, whether extra-dural, sub-dural, or intra-cerebral. Only second in importance to the fact of its presence is the diagnosis of its *situation* in regard to the surface of the brain. It must be realised that hæmorrhage in the cranial cavity, once started, is of a progressive nature, and calls urgently for immediate operative relief.

The chief difficulty in diagnosis is the fact that the early symptoms are irritative, and the condition is difficult to distinguish from the state termed “cerebral irritation.” The classical diseases listed for differential diagnosis, alcohol and opium poisoning, uræmia, diabetic and hypoglycæmic coma, etc., are not difficult to distinguish *provided their possibility is borne in mind*, and patients are examined for signs and symptoms of such conditions.

We may list factors in the diagnosis under two main headings as follows :

(1) *Factors which indicate or suggest the presence of an intra-cranial hæmorrhage.*

- (a) The recurrence or occurrence of symptoms after recovery from concussion.
- (b) The onset of paralyses which were not observed to be present immediately after the accident.
- (c) The occurrence of convulsions.
- (d) The progressive nature of the symptoms, especially a change from a state of excitability to unconsciousness. (The attendants should be warned to watch for this, and not to conclude too readily that the patient has fallen asleep.)
- (e) Blood in the cerebro-spinal fluid.
- (f) Pupillary changes.
- (g) Persistent vomiting.
- (h) Slowing of the pulse, rise of blood-pressure, and deep slow respirations. (This indicates bulbus irritation, and should not be waited for in diagnosis.)

(2) *Factors which suggest the site of the lesion.*

- (a) The mode of onset of the paralysis. First, rigidity of the limbs on the opposite side to the lesion ; then, flaccidity.
- (b) The temperature is usually higher in the paralysed limb.
- (c) Babinski's sign and loss of the abdominal reflexes.
- (d) The pupillary changes. From a contracted state with sluggish light reaction on the side of the lesion, changing to dilated and fixed condition.

Mr. Wilfred Trotter very ingeniously suggests that in a deeply unconscious patient, where there is difficulty in deciding the side of the hæmorrhage, an intravenous hypertonic saline may, temporarily, sufficiently relieve the intra-cranial pressure as to present a definite clinical picture. This is admirable, but we must insert a warning against attempting to obtain the same result by lumbar puncture, when sudden death might occur by wedging the medulla in the foramen magnum. There are various other factors which may suggest the side of an intra-cranial hæmorrhage, but they may be deceitful, as the hæmorrhage may occur on the opposite side of the brain from contre-coup. They are :

(a) The presence of fractures of the skull, as indicated by an X-ray, or of bruising of the scalp.

(b) The side of the injury and its nature and direction. Non-penetrating bullets cause gross local injury; large blunt weapons, sand-bagging, and falls on the head are more liable to promote diffuse injuries, etc.

THE TECHNIQUE OF THE OPERATION OF CEREBRAL DECOMPRESSION

To recapitulate, the indications for this operation in the treatment of head injuries are :

- (1) For cases of concussion with symptoms of delayed recovery.
- (2) For relief of cerebral irritation, which is not resolving after a period of rest in bed.
- (3) For intra-cranial hæmorrhage.

Method. The position of choice for a simple decompression operation is the *sub-temporal region*. Other areas may, however, be selected if the clinical condition is complicated by fractures, or if there are localising signs elsewhere. Local damage to the skin in the sub-temporal region may modify the usual incision or may preclude operation. Should the evidence point to the compression being primarily in the posterior cranial fossa (rare in the surgery of head injuries, though more common in tumours), then the decompression must be made in the posterior cranial region.

Anæsthetic. Most English surgeons prefer to use some form of general anæsthetic and to supplement it locally. Patients in this country do not tolerate well the noise of opening the skull and general "theatre tension" under local anæsthetic. The best general anæsthetic is continuous gas and oxygen, if a skilled administrator is available. Cyanosis must be prevented. When administered through an intra-tracheal tube it gives the surgeon free access to the operation field. It is important to supplement any general anæsthetic by local infiltration with generous amounts of freshly sterilised novocaine, $\frac{1}{2}$ per cent, with adrenalin. This injection is valuable, not only on account of its anæsthetic nature, but also because of the œdema it produces in the scalp tissues. When the scalp is incised it is easy, in the œdematous layers, to secure the vessels with ordinary hæmostats. Hæmorrhage is negligible even in large flap incisions, if such a procedure is carried out.

Incision. For a simple decompression the best incision is undoubtedly a 3-4 inch vertical incision, made midway between the external angular process of the frontal bone and the front of the pinna. It extends down as far as $\frac{1}{2}$ inch above the mid-point of the zygomatic arch. This incision is better than the old horseshoe flap for the following reasons :

- (a) It is time-saving.
- (b) It gives a sound muscle and scalp scar over the cranial defect which is left.
- (c) Should occasion arise, it can readily be extended, curving backwards or forwards as necessary.

The temporalis muscle is split in the line of the incision, the periosteum reflected and the bone exposed. For opening the skull we prefer a hand-driven burr to a trephine (fig. 853). With a gimlet or small

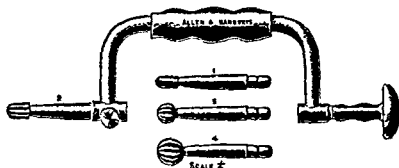


Fig. 853.—A USEFUL BRACE AND BURS.

punch, a small hole is made to lodge the centre of the burr, and the skull is drilled. As soon as the first burr is felt to be "almost through," the enlarging burr is engaged, which opens out the conical hole made by the first burr. With a Horsley's elevator the rest of the inner table is lifted out. During the period of drilling, an assistant keeps the field irrigated with normal saline. The opening in the skull is next enlarged with bone nibbling forceps. It is enlarged as desired, but mainly in a downward direction. The dura mater is inspected and its tension and the presence or absence of pulsation noted. Subsequent steps will depend upon the condition which led to the operation, or upon the findings at this stage.

If a simple decompression operation is being performed, it is only necessary to round off the edges of the bony defect and then close up the wound. The split temporalis muscle is brought together with sutures, and the scalp is closed with drainage. If there is any question of possible subdural hæmorrhage, or if the dura bulges into the

opening in the skull, it is better to open the dura. If the intra-cranial pressure is very considerable two things should be done :

- (a) A large skull opening made. This prevents herniation of the brain through a small hole, which might lead to its disintegration.
- (b) The lateral ventricle tapped with a lumbar puncture needle—passed into the descending horn of the ventricle. This rapidly lowers the intra-cranial tension and permits safe and easy opening of the dura mater.

The dura mater is opened through an avascular area with a cruciate incision. If there are large meningeal vessels running over the dura, they should be underrun with a fine needle, or coagulated with the diathermy before opening the dura. If a sub-dural hæmorrhage is found, it is dealt with *secundum artem* by irrigation of the clot, and suction. In closing the dura it is only necessary to replace the flaps. Sutures in the dura are quite unnecessary.

THE OPERATION FOR EXTRA-DURAL HÆMORRHAGE

The same technique is used until the skull is opened. The blood clot which has caused the compression will at once be evident. The skull opening is enlarged downwards as before. The clot is removed by irrigation and suction, and if necessary a scoop. In a large percentage of cases this is all that is necessary. The brain should expand and pulsate, and there should be a definite improvement in the pulse and respirations. The area is next inspected to discover whether there are any signs of further bleeding. If there is still some bleeding the middle meningeal vessels, or their anterior branches (the common source), are sought for. They are usually adherent to the surface of the dura mater. When the bleeding vessel is found it may be dealt with by underrunning or by diathermy. If the vessel is running in a groove or canal in the bone, it may be plugged with a sharpened piece of matchwood. If the brain has expanded and pulsates normally, the dura is not opened. It should not be forgotten, however, that hæmorrhage may be both extra-dural and sub-dural, and if the dura mater bulges unduly, or there is discoloration under it, it should be opened as described previously.

It should not be necessary to emphasise that, if the diagnosis is definite but no hæmorrhage is found, the skull should be opened on the other side. The possibility of a bilateral hæmorrhage must also be kept in mind.

CHAPTER II

INTRA-CRANIAL TUMOURS

THEIR DIAGNOSIS, CLINICAL FEATURES, AND INDICATIONS FOR TREATMENT

DURING the last twenty years considerable attention has been directed to the peculiar problems presented by tumours inside the cranial cavity. The classical methods of examination of a patient, namely, inspection, palpation, percussion and auscultation, cannot be applied in these cases, and a special technique has been evolved to enable the surgeon to surmount the barrier presented by the rigid bony casing of the skull. This technique involves the application of the principles of neurology, examination of the visual fields and retinæ, estimation of the endocrine system, skiagraphy, and even diagnostic procedures involving surgical operations, such as ventriculography and encephalography, the final resort being an exploratory craniotomy, this last being analogous to, but in its extent not comparable with, a laparotomy for intra-abdominal lesions.

It has been found that when these methods have been applied by experienced neuro-surgeons, intra-cranial tumours can be diagnosed with a reasonable degree of accuracy. Previously, the term "cerebral tumour" was used almost synonymously for the more modern term of "intra-cranial tumour," but it is important to realise that tumours arising within the cranial cavity may find their pathological basis in any of the histological structures found within the skull, since, for example, they may arise from blood-vessels, nerve-sheaths, endothelial coverings of the brain, the skull wall, or from the nerve elements and supporting tissues of the brain itself. Cysts in the cranial cavity may behave as tumours, and may be traumatic, inflammatory, or parasitic in origin.

Again, it was previously considered that, if syphilis and tuberculosis could be excluded, these tumours were all "gliomata." To-day the

neuro-surgeon has not only to diagnose the presence of an intra-cranial tumour, but also its situation and as far as possible its nature, though at the present time the latter rather consists in an estimation of probabilities.

The three classical cardinal signs of a "cerebral tumour," namely, headache, vomiting, and optic neuritis, are realised to be no longer signs of a cerebral tumour, but of a generalised rise of intra-cranial tension, and the aim of the surgeon should be to diagnose a cerebral tumour before such an event has occurred.

The only true sign of an intra-cranial neoplasm is a steady progressive loss of function of some part of the brain or cranial nerves. This may be associated with malfunction evidenced by fits of various forms. Frequently, however, it is difficult, if not impossible, on such a finding alone, to establish or even suspect the presence of a tumour, and cases wait until signs of extension of the tumour make the diagnosis unmistakable.

It is important to realise that intra-cranial neoplasms represent 1.8 per cent of all neoplasms, and further that a large proportion of these neoplasms are originally innocent in nature and susceptible to treatment.

This chapter is less concerned with operative details than with an evaluation of the indications for surgical and other methods of treatment. It is perhaps an aphorism to say that the diagnosis of intra-cranial tumours is only made by the constant realisation of their possibility and a knowledge of the typical syndromes of the commoner varieties of cerebral neoplasm. These will be dealt with later.

It is further important to be able to recognise the pathology of these lesions at operation, as the line of treatment to be carried out varies considerably.

Intra-cranial neoplasms may cause symptoms by their local destruction, or by blockage of the circulation of the cerebro-spinal fluid, and in this way produce remote effects, or finally by causing a generalised rise of intra-cranial tension.

It should be realised that, on the whole, intra-cranial tumours occur in childhood and the first half of adult life, and are uncommon in old age. In childhood and young adult life the occurrence of any progressive derangement of function of the central nervous system should lead to the suspicion of an intra-cranial tumour.

A CONSIDERATION OF THE COMMONER SYMPTOMS AND SIGNS OF INTRA-CRANIAL TUMOURS

Headache. The mechanism of production of headaches is still under discussion. It has been proved at operation that the meninges about the base of the skull are sensitive to distortion, and the headache of tumours in this region may thus be explained. Further, tumours growing at a distance may cause a dislocation of the base of the brain and thus give rise to headache. Alteration in tension in the cerebro-spinal fluid system is known to cause headaches, and this may occur at any early stage with certain tumours. Headaches should not lightly be classified as "migrainous" unless there is definite supporting evidence in the way of family history, teichopsia and fortification spectra, a hemicrania, or the complete definite series of stages of the true migrainous attack. If the headache is bilateral, intermittent, and accompanied by any palsies, an intra-cranial tumour is at once suspected. These headaches are often aggravated by any straining effort. All cases of migraine are often worthy of regular re-examination, to ensure that there is no increase in intra-cranial pressure. The headache of intra-cranial tumours is not usually of much value in the diagnosis of the situation of the tumour. Bitemporal headaches of a dull aching character which may be relieved by pressure on the skull are suggestive of tumours in the region of the pituitary fossa. The headache which is often an early sign of a tumour has to be diagnosed from the headache of raised intra-cranial pressure when there is some general diminution of all the mental faculties. Examination of the optic fundi should always be performed in any

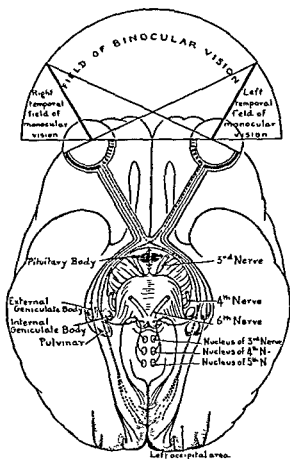


Fig 854.—DIAGRAM SHOWING THE CONNECTIONS OF THE OPTIC NERVES TO THE OCCIPITAL CORTEX. THE PITUITARY GLAND IS SITUATED JUST BEHIND THE CHIASSMA AND ANY ENLARGEMENT OF THIS GLAND WILL CAUSE PRESSURE ON THE CHIASSMA.

patient who complains of repeated headaches. The presence of papilloedema is a sure indication of raised intra-cranial pressure, and an examination of the fundi is more readily performed and is safer than lumbar puncture. If recurrent headaches are complained of and no other symptoms and no physical signs are found on clinical examination, an X-ray of the skull and an estimation of the visual fields is always worth while.

Visual Disorders. Disorders of vision and the visual apparatus such as loss of visual acuity and diminution of the visual fields, diplopia



Fig. 853.—PHOTOGRAPH OF PATIENT WITH ACROMEGALY. THE ELONGATION OF THE FACE, THE INCREASED SIZE OF THE LOWER JAW AND HANDS CAN READILY BE SEEN.

and squint, are important indicators of intra-cranial damage. The extent of the optic nerve fibres and relays in the cranium render them liable to involvement in many cases, while, as previously mentioned, the nerve head gives an indication of intra-cranial tension (see fig. 854). Tumours in the region of the optic chiasma (pituitary lesions, supra-sellar tumours), (figs. 855 and 856), and tumours in the region of the occipital cortex will be associated with visual defects at an early stage, and indeed this may be their primary symptom. Frequently visual defects may be very difficult to assess as the patients may be unco-operative. If papilloedema is present in these more difficult cases, it

may be worth while attempting to secure temporary co-operation for estimation of the fields by an intravenous injection of 50-100 cc. of 50 per cent glucose saline, which will lower the intra-cranial pressure temporarily. The presence of papillædema in one disc, and primary optic atrophy in the other, will point to a tumour in direct contact with the optic nerve on the side of the primary optic atrophy.

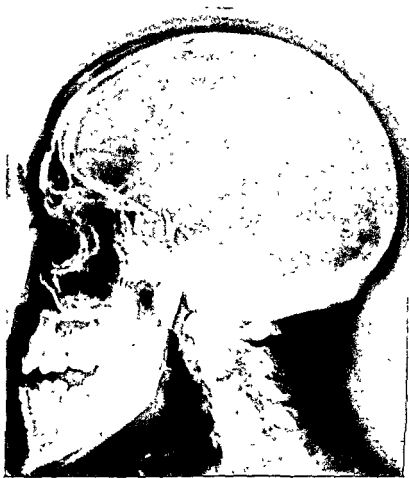


Fig. 856.—SKILAGRAM OF SKULL OF ACROMEGALIC PATIENT SHOWING POSITION OF RADON SEEDS WHICH WERE INSERTED INTO THE PITUITARY BODY THROUGH AN OSTEOPLASTIC FRONTAL FLAP.

Recurrent Vomiting. This symptom in childhood tends to replace headache as a major symptom. The vomiting frequently occurs in the early morning. The characteristics of cerebral vomiting are the absence of preliminary nausea and the absence of abdominal pain, but these are inconstant and have been unnecessarily stressed. Vomiting, like headache in these cases, tends to be intermittent, and children with tumours will vomit and often call for food immediately afterwards, thus stressing the absence of abdominal lesions.

adult. This difference is due to the fact that the skull sutures are not firmly united, and the head can therefore expand to accommodate the neoplasm. Separation of the sutures is diagnostic of hydrocephalus (whether due to tumour or other cause), and this separation is readily discoverable radiologically, and clinically (by the presence of the "cracked pot" sound on percussion of the skull). Headaches are less common as a symptom, while vomiting tends to be more common.

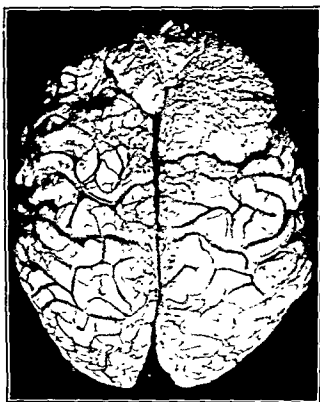


FIG. 559.—PHOTOGRAPH OF A BRAIN WITH AN ENORMOUS MENINGIOMA OF THE RIGHT FRONTAL LOBE EXTENDING INTO THE LEFT FRONTAL LOBE. THE PATIENT HAD WELL-MARKED MENTAL CHANGES PRIOR TO DEATH.

Raised intra-cranial tension as shown by the occurrence of papilloedema is still common, in spite of the fact that the skull can yield. This is in part due to the fact that about 60 per cent of intra-cranial tumours are sub-tentorial in children. In this situation obstruction to the circulation of the cerebro-spinal fluid occurs early and hydrocephalus is marked. Associated with this type of tumour is neck stiffness, another common sign in children. Vomiting of a cerebral type combined with neck rigidity, when evidence of meningitis is absent in the cerebro-spinal fluid, constitutes a strong indication of a sub-tentorial tumour.

Local Examination of the Head is of importance in suspected cases. While negative findings will not rule out the possibility of a tumour, positive findings are often of great value. The "cracked pot" note on percussion in childhood has already been alluded to. Other signs in the head are :

Local tenderness of the skull bones or scalp ; this is usually over the distribution of the 5th cranial nerve and indicates meningeal involvement by the tumour or, of course, extension of the tumour into the skull itself. A bony boss may be present over a meningioma. Cutaneous nævi, especially if multiple, may suggest the presence of an intra-cranial angioma. A bruit is not infrequently heard with these angiomata and rarely over other highly vascularised tumours (meningiomata, gliomata, etc.). A bruit used to be said to indicate the presence of an intra-cranial aneurysm, but the two are now known to be only rarely associated.

In estimating the likelihood of any given patient having an intra-cranial tumour and especially with regard to the nature of such a tumour, too much attention cannot be paid to the history of the mode of onset. The forward march of symptoms in spite of remissions, together with the gradual entrance into the picture of new features, may often point irresistibly to the presence of a tumour.

Confirmatory Tests of Established Value. The history, signs and symptoms, and clinical examination of a suspected patient not infrequently produce equivocal findings, and the neuro-surgeon is then driven to accessory methods of investigation. Some of these methods will probably be used in every case, owing to their ease of performance and absence of danger, while others will be reserved for the more difficult cases.

Radiology. An X-ray is simple to take, causes no annoyance to the patient, and may supply valuable evidence. Stereoscopic views may be necessary.

Excluding special radiological methods such as ventriculography and encephalography, the following positive findings may be obtained on radiological examination. These may be taken in chronological order :

Children.

- (1) General thinning of the skull wall, presenting a beaten silver appearance due to increased intra-cranial tension. This may, of course, be due to other forms of illness, especially in infants.
- (2) Separation of the sutures.

Adults.

- (3) Local erosion of bone. } Common with meningioma class of
- (4) New formation of bone. } tumour.
- (5) Erosion of the internal auditory meatus and the adjacent petrous bone in acoustic nerve tumours.
- (6) Increased vascularisation.
- (7) Changes in the pituitary fossa or distortion of the clinoid process.

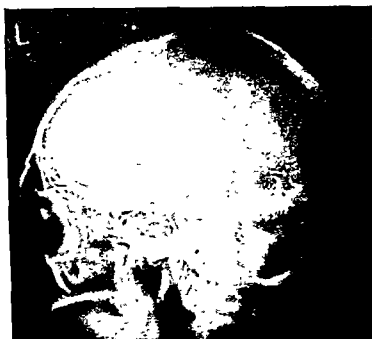


Fig 860.—SKILAGRAM SHOWING WELL-MARKED CALCIFICATION OF THE CHOROID PLEXUSES.

- (8) Calcification. Seen with supra-sellar tumours (in cranio-pharyngiomata, in angiomas, in tumours of the choroid plexus, and occasionally in a normal choroid plexus) (fig. 860).
- (9) Pineal shift. The pineal body is radio-opaque from calcification in about 60 per cent of adults over 30 years of age. Normally it appears as a small shadow above and behind the sellar turcica, exactly in the mid-line (fig. 861). A tumour growing in either side of the supra-tentorial region may displace the pineal gland to the opposite side.

A consideration of these possibilities reveals the fact that frequently valuable aid can be obtained from a simple radiological examination.

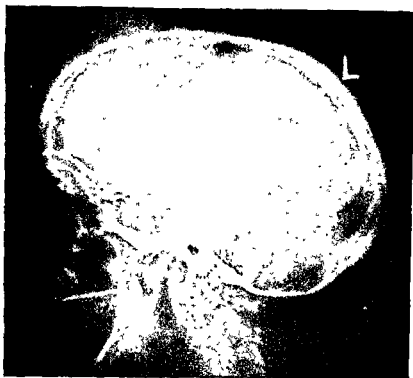


Fig. 861.—SKIAGRAM SHOWING CALCIFIED PINEAL GLAND.

This is even more important when it is remembered that the tumours which are most amenable to surgical treatment, viz. : the meningiomata, pituitary tumours, supra-sellar craniopharyngiomata and neurinomata, very frequently show some radiological peculiarity (fig. 862).

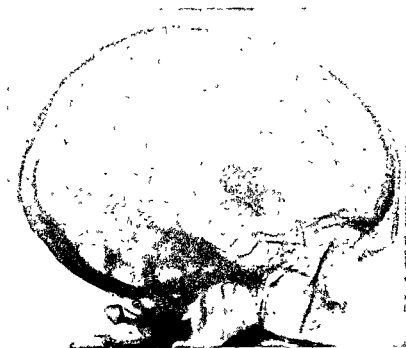


Fig. 862.—SKIAGRAM OF SKULL SHOWING CALCIFIED MENINGIOMA ARISING FROM THE LESSER WING OF THE SPHENOID. A DECOMPRESSION OPERATION HAS BEEN PERFORMED PRIOR TO THE REMOVAL OF THE TUMOUR AT A SECOND OPERATION.

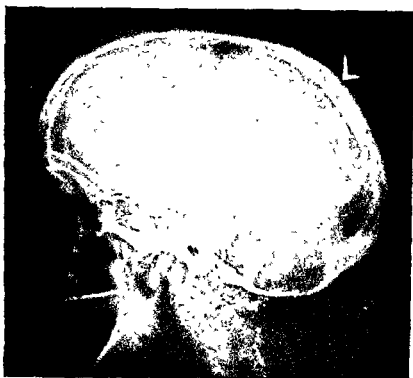


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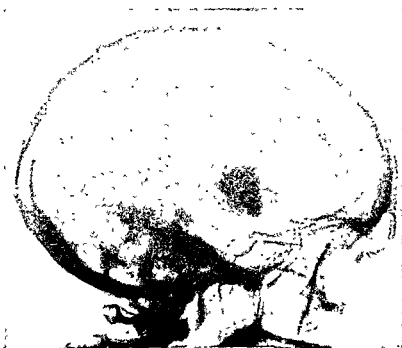


Fig. 862.—SKIAGRAM OF SKULL SHOWING CALCIFIED MENINGIOMA ARISING FROM THE LESSER WING OF THE SPHENOID. A DECOMPRESSION OPERATION HAS BEEN PERFORMED PRIOR TO THE REMOVAL OF THE TUMOUR AT A SECOND OPERATION.

The Cerebro-spinal Fluid. With the exception of the finding of abnormal pressure-states, examination of the lumbar fluid is likely to be negative in cases of suspected intra-cranial tumours. Where the pressure is known to be raised, great care must be taken to prevent sudden escape of the fluid. The pressure should always be taken before fluid is withdrawn. The protein content of the fluid may occasionally be raised, but seldom above the level of 1 per cent. When the tumour is intra-ventricular a great increase of protein may be observed. Pleocytosis is not usual unless the tumour is in contact with the meninges, when an increase in mononuclear cells may be found.

Ventriculography and Ventricular Estimation. By replacing the fluid present in the ventricular system with air, the neuro-surgeon can contrive to obtain a skiagram showing the outlines of the ventricles. This method, termed ventriculography, is not without risk; while in certain cases it may be misleading, in other cases it may be invaluable. The method is usually combined with the procedure of ventricular estimation where the amounts of fluid which can be obtained from either lateral ventricle is measured. Both ventricles should be punctured simultaneously (the technique is described on page 1802). The degree of resistance to the entering needle, the depth at which the ventricle is reached, and the amount and character of the fluid which can be withdrawn are all important points and may yield more positive help than the subsequent ventriculogram. Slight differences in volume between the two lateral ventricles are not significant, but a difference of 10 cc. is pathological. Collapse of one ventricle may be associated with dilatation of the other. Dilatation of both ventricles indicates internal hydrocephalus of the brain stem of sub-tentorial origin (figs. 863 and 864). A ventriculogram may reveal filling defects of the third or lateral ventricles and thus give confirmatory evidence of a tumour. Ventriculography should only be performed when it is possible for the surgeon to proceed with a decompression, if need be, as acute symptoms may follow the examination. It is a procedure not without risk, and thus is only reserved for difficult cases. In some clinics encephalography is used. Here air is introduced at lumbar puncture with the patient in a sitting position and the air is allowed to displace the cerebro-spinal fluid. This method is not applicable where the intra-cranial tension is high, as it is liable to cause severe headaches and the results are uncertain.

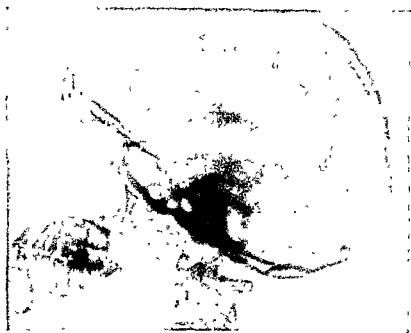


Fig. 863.—LATERAL VENTRICULOGRAM SHOWING WELL-MARKED INTERNAL HYDROCEPHALUS DUE TO A PINEAL TUMOUR.



Fig. 864.—ANTERO POSTERIOR VENTRICULOGRAM SHOWING EQUAL DILATATION OF BOTH VENTRICLES DUE TO PRESSURE ON THE ITER FROM A PINEAL TUMOUR

General Examination of the Other Systems. This is, of course, always performed, and even if it does not throw light on the patient's neurological problem it may supply valuable data in assessing the risk or value of operative treatment. The function of the cardio-vascular system, especially the blood-pressure and condition of the smaller vessels, is assessed. A careful search is made for any clinical features suggesting a primary malignant lesion which might be producing secondary deposits in the skull. The question of venereal disease is investigated and the possibility of tuberculosis excluded. The possibility of a cerebral abscess is considered and the common aural conditions, middle ear disease and bronchiectasis excluded. Any previous history of head injury will require careful consideration, as the patient's signs may be due to a chronic subdural hæmatoma. The possibility of a parasitic cyst should be borne in mind. The syndromes of all the neurological conditions must be considered.

The above paragraphs reveal both the complexity and the interest of the problem of diagnosis and demonstrate the need for mature consideration of every case.

The diagnosis of the presence and situation of a tumour thus becomes a matter of consultation between the neuro-surgeon and the neurologist. As a final practical counsel, operation must be advised in the uncertain cases, when considerable doubt exists. This becomes imperative if papilloedema is present, in order to avert the risk of secondary optic atrophy and blindness. As a sequel to this advice it follows that the surgeon must be a neuro-pathologist, so that on exploration he may be able to recognise the nature of any particular finding and adjust his treatment accordingly. The "tumour" for which the skull was explored may prove to be a tuberculoma or a gumma. It may be angiomatous and too vascular to remove; it may be a medulloblastoma too malignant to be worth removal, but worth subsequent irradiation. In each of these instances exploration is justifiable, though attempts to remove the tumour would not be. In the first instance the tuberculoma may become encapsuled and the relief of intra-cranial pressure is beneficial to the patient. In the second, operation is necessary as it is notorious that anti-syphilitic remedies are ineffective in cerebral cases until decompression has been performed. They are subsequently often very effective.

With malignant tumours deep X-ray therapy must never be attempted unless a previous decompression has been performed. Reactionary œdema may follow X-ray treatment, and in the absence of a decompression opening a fatal rise of intra-cranial tension might

result. It will be seen, therefore, that as in skilled hands the mortality of a simple craniotomy is low, it is wiser to open the skull in doubtful cases and run the risk of an unnecessary operation rather than run the risk of allowing a patient to become blind from optic atrophy.

As the general technique of operative procedures is described in Chapter III, it will be sufficient here to give a brief account of the commoner tumours, how they may be recognised at operation, and their suitability for treatment.

THE COMMONER INTRA-CRANIAL NEOPLASMS

It is impossible to describe at length the symptom-complexes of the various sub-groups of tumours, and for the purpose of this chapter the commoner tumours only are considered unless the type of tumour, though rare, is especially suited to treatment.

Tumours of the Glioma class, that is, of cells of the supporting tissue of the brain, account for rather more than 40 per cent of all intra-cranial tumours. The gliomata have been divided into numerous sub-classes, especially by the American writers, chiefly according to the predominating cell type. It has to be remembered, however, that these are not pure cell tumours, many varieties of cells being found in each tumour. Three definite sub-classes, however, are commonly recognised, and each produces a definite syndrome. They will now be considered.

(1) *Glioblastomata*. These tumours are very common, and account for 10 per cent of all intra-cranial tumours. They are very rapid in growth and are confined almost exclusively to the cerebral hemispheres, and to adults. They are not capsulated, and the average survival length is only twelve months. The tumours degenerate very readily and hæmorrhages are common (fig. 865). These tumours were originally described as gliosarcomata. The first signs may be those of increased intra-cranial pressure in an adult in the forties. Sometimes localising signs, such as hemiparesis, hemiplegia, or aphasia may precede the general intra-cranial signs. Signs may appear with suddenness owing to hæmorrhages occurring in the tumour. The progressive changes in cerebral function associated with most tumours are not a feature of these glioblastomata, rather a series of sudden cerebral attacks. The diagnosis from vascular lesions of the brain may be difficult. When the diagnosis of tumour is made, the question of treatment arises. An exploratory craniotomy is always worth while in case the tumour is after all of a different pathology. At operation

the tumour is recognised by the absence of a capsule, the gross surrounding oedema of the brain tissues, the presence of hæmorrhages, and the multi-coloured appearance resulting. The tumour is usually sub-cortical, and at first only smoothed out gyri and sulci may be observed. The surface of the tumour is very vascular. Once the fact of a glioblastoma has been established, we do not advise any further operative treatment as the results are most disappointing. Either so much brain tissue will have to be removed that the patient will be deprived of

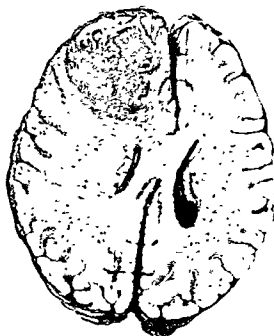


Fig. 865.—PHOTOGRAPH OF BRAIN SHOWING A LARGE GLIOBLASTOMA IN LEFT FRONTAL LOBE. THERE IS NO SIGN OF A CAPSULE AND THROUGHOUT THE TUMOUR THERE ARE HÆMORRHAGES.

considerable cerebral function and left a living wreck, or else the tumour will soon recur. The tumours unfortunately do not react well to irradiation either, as hæmorrhages are common, but after decompression irradiation is always worth a trial.

(2) *Astrocytomata*. In contra-distinction to the glioblastoma the astrocytoma is the most indolent of the gliomata and in consequence carries the best prognosis. These tumours may occur anywhere in the brain. When they occur in the cerebellum their symptoms appear in childhood, and the tumour is found in the cerebellar hemispheres and causes ataxic symptoms, in contra-distinction to the medulloblastoma, which affects the vermis. When the tumour occurs in the cerebral

hemispheres, symptoms do not appear until adult life. The tumours are avascular and tend to liquefy, causing large cysts, the tumour remaining as a nodule in the centre of the cyst. Thus their consistency may be soft or firm. There is no true capsule. At operation the tumour is located by its greyish avascular appearance. The cysts contain a yellow clear fluid which clots on exposure; the cyst is smooth-walled and glistening, unlike the rugged cavity of a glioblastoma. The prognosis, if the tumour is accessible, is good. The tumour should be removed. If the tumour is cystic the solid nodule in its wall must be searched for and removed or else the tumour will soon reform. A course of irradiation after removal should be advised.

(3) *Medulloblastomata*. These tumours are particularly tumours of childhood. Their common site is the vermis of the cerebellum. They account for about 40 per cent of cerebellar neoplasms—the rest being the astrocytomata described above and the rarer ependymal tumours. They affect children from the age of two years until late adolescence. Characteristic cerebellar signs such as ataxia, etc., do not commonly occur. The earliest signs are two in number, which occur with great regularity, namely, early-morning headache and vomiting. The child who complains of headache before breakfast and vomits should be very carefully watched for the possible commencement of the other phenomena of a medulloblastoma. These are listlessness, squinting, loss of acuity of vision, and finally disorders of motion. Neck rigidity may be present in certain cases.

The tumour is very invasive and tends to spread in the arachnoid and pia mater. It may thus spread over the whole cerebrum and down the spinal cord, nodulæ being found even on the cauda equina roots. So common is this spread that the tumour used to be known as “sarcomatosis of the meninges.”

DIAGNOSIS AND TREATMENT

The final diagnosis is made by craniotomy and exploration. An astrocytoma can simulate the medulloblastoma and is to be suspected if symptoms have existed for long or nystagmus is present. Ependymomata can only be differentiated at operation. These tumours are also mid-line and tend to project between the cerebellar tonsils, but the ependymoma is whiter, tougher, and less diffuse than the vascular red-grey solid medulloblastoma. Biopsy may be necessary. These tumours are not worth the difficulty and risk of removal, as early recurrence is

inevitable and the tumour has probably already spread widely in the meninges. The tumours are very sensitive to irradiation, and the best treatment at the present time is exploratory craniotomy to decide the diagnosis and permit decompression, followed by a course of deep X-ray therapy to the whole brain and spinal cord. The immediate prognosis is then often surprisingly good, but later recurrence is common.

Turning now to other varieties of intra-cranial tumours, the second commonest class consists of tumours of the meninges, and especially the tumour now known as the meningioma.

MENINGIOMATA

These are characteristically tumours of adult life, occurring most frequently in the para-sagittal central region. Their other common sites are near the cribriform plate of the ethmoid, near the basi-sphenoid and in the temporal fossæ. These tumours are thought now to arise in the arachnoidal granulations and hence their common occurrence in the para-sagittal region by the venous laminae. The tumour is

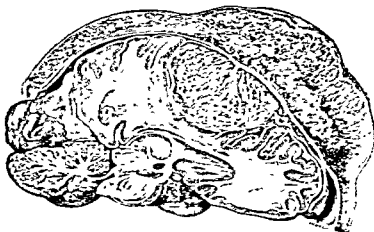


Fig 566.—DRAWING OF A LARGE MENINGIOMA SHOWING WELL-MARKED HYPERTROPHY OF THE SKULL. THE TUMOUR ORIGINATED IN THE PARA-SAGITTAL CENTRAL REGION.

usually a rounded mass and sharply defined, and firmly attached to the dura mater. The cerebral tissue is not invaded but is compressed by the growing tumour. Large vessels enter and leave the tumour from the pial circulation. The cranial bones are commonly invaded. The tumour grows steadily and progressive symptoms of cerebral dysfunction result. Attacks of twitchings, paresis, or loss of sensation may be the first sign, commonly in the foot and lower limbs, and subsequently spreading up one side of the body (the contra-lateral side to

the tumour). Changes in the cranial vault may be palpable, there may be local erosion and hyperostosis (fig. 866), a bruit may be heard, and the tumours are frequently highly vascular. Signs of rise of intra-cranial tension only occur later as the tumour is slow growing and the brain has time to accommodate. When a rise of intra-cranial tension



Fig. 867.—LATERAL SKIAGRAM OF SKULL SHOWING COMMENCING EROSION OF THE BONE DUE TO A PARA-SAGITTAL MENINGIOMA. X-RAY PRIOR TO OPERATION.

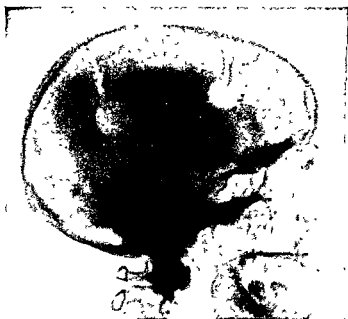


Fig. 868.—LATERAL SKIAGRAM OF SKULL SHOWING OSTEOPLASTIC FLAP REPLACED AFTER REMOVAL OF MENINGIOMA. (SAME CASE AS FIG. 867.)

inevitable and the tumour has probably already spread widely in the meninges. The tumours are very sensitive to irradiation, and the best treatment at the present time is exploratory craniotomy to decide the diagnosis and permit decompression, followed by a course of deep X-ray therapy to the whole brain and spinal cord. The immediate prognosis is then often surprisingly good, but later recurrence is common.

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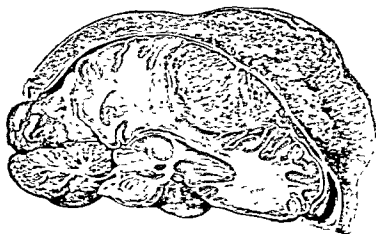


FIG. 555.—DRAWING OF A LARGE MENINGIOMA SHOWING WELL-MARKED HYPEROSTOSIS OF THE SKULL. THE TUMOUR ORIGINATED IN THE PARA-SAGITTAL CENTRAL REGION.

usually a rounded mass and sharply defined, and firmly attached to the dura mater. The cerebral tissue is not invaded but is compressed by the growing tumour. Large vessels enter and leave the tumour from the pial circulation. The cranial bones are commonly invaded. The tumour grows steadily and progressive symptoms of cerebral dysfunction result. Attacks of twitchings, paresis, or loss of sensation may be the first sign, commonly in the foot and lower limbs, and subsequently spreading up one side of the body (the contra-lateral side to

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Fig 867—LATERAL SKIAGRAM OF SKULL SHOWING COMMENCING
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X-RAY PRIOR TO OPERATION.

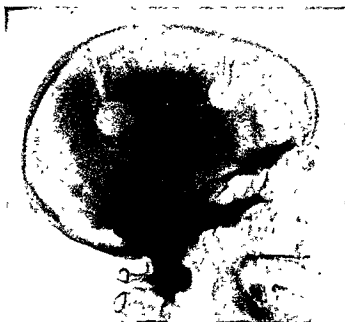


Fig. 868.—LATERAL SKIAGRAM OF SKULL SHOWING OSTEOPLASTIC
FLAT REPLACED AFTER REMOVAL OF MENINGIOMA. (SAME CASE AS
FIG. 867.)

is found the tumour is usually very large. These tumours are essentially benign, they grow locally, and they only invade the skull bones by pressure. They do not metastasise and when completely removed they do not recur. They compress the cerebral tissue in their vicinity, but when this compression is removed the cerebral tissue resumes function in a dramatic way.

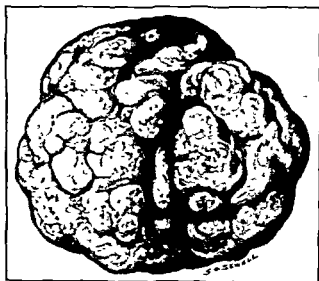


Fig 82.—PHOTOGRAPH OF ACTUAL SIZE OF TUMOUR REMOVED FROM PARA SAGITTAL REGION (SEE FIGS. 87 AND 828.)



Fig 870.—MICROSCOPICAL DRAWING MADE FROM MENINGIOMA REMOVED FROM PARA SAGITTAL REGION. (SEE FIGS. 877-879.)

The Treatment is Removal. This may, however, be difficult for two reasons :

(1) Vascularity of the tumour. The control of its blood supply may tax the surgeon's ingenuity to the utmost. Multiple-stage operations may be necessary. Recourse may be had to silver clips, muscle packs, and electro-coagulation. Progress may be slow and tedious, but hæmorrhage must be controlled.

(2) Inaccessibility of the tumour. This also presents a stumbling block and special operative methods may have to be devised. The tumour may be in the region of the olfactory groove, the cavernous sinus, or behind the entrance of the superior cerebral veins (which should not be ligatured for fear of paraplegia).

Successful removal is, however, most gratifying. The patient is completely cured and has been rescued from a progressive loss of cerebral function which would end in death (figs. 867, 868, 869 and 870).

Pituitary Tumours and Other Growths in the Region of the Sella Turcica. It is not proposed to give a detailed description of the various types of pituitary lesions, for which the reader is referred to general text-books. Localising signs for tumours in this region are many and exact. The X-ray appearance is characteristic—the sella turcica is ballooned or excavated out. It is important to differentiate the supra-sellar tumours from the true pituitary lesions. The former are now commonly known as craniopharyngiomata. Rarely they may occur in the pituitary fossa (sub-diaphragmatic tumours), and it is then extremely difficult to distinguish them. The main points of differentiation may be listed as follows :

<i>Pituitary "Adenomata."</i>	<i>Craniopharyngiomata.</i>
Age of onset—late adolescence or adult life.	Symptoms usually present before puberty.
Dyspituitarism an early sign, polyuria uncommon.	Polyuria may be an early sign. Acromegaly, etc., never found.
Visual changes symmetrical.	Visual changes vary and are usually bizarre.
Radiogram shows ballooning of the pituitary fossa.	Radiogram shows pituitary fossa normal, but irregular supra-sellar calcification. Irregularity of the clinoid processes.

Adenomata of the anterior lobe of the pituitary are named according to the type of cell which they resemble.

(1) Chromophobe adenoma is the commonest type of pituitary tumour, and it gives rise to hypopituitarism. It is composed of masses of non-granular cells showing no specific staining properties. Probably the cells are an embryonic type of the chromophobe cells which occur in the normal gland. There are no eosinophil cells, and the tumour does not furnish any endocrine secretion.

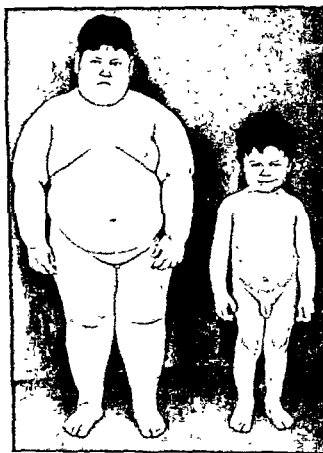


FIG. 521.—HYPOPITUITARISM. PHOTOGRAPH SHOWING THE TWO TYPES MET WITH IN CHILDHOOD.

(2) Chromophil or eosinophilic adenoma is made up of granular eosinophil cells that resemble the normal epithelium of the anterior lobe. The cells vary in size and shape, and there are generally a few chromophobe cells present as well. This type of tumour produces symptoms of hyperpituitarism.

(3) Mixed adenomata resemble the general chromophobe tumour with some eosinophil cells scattered through it. These tumours give

rise to "dyspituitary" or mixed syndromes, owing to the blending of hypo- and hyper-pituitary features.

Hyperpituitarism is always associated with the anterior lobe, and shows itself either as gigantism in children or acromegaly in adults, the former being a relative increase of all parts of the body, while in the latter the chief changes are in the skull, spine, and distal portions of the extremities (see figs. 855 and 856).

In hypopituitarism, the effects also differ as they occur in childhood or adult life. When developed in childhood, two types are noted: one in which the child is infantile in character, with small bones, and fine hairless skin (Lorain's disease); the other in which there is great and generalised deposition of subcutaneous fat, with sex infantilism and increased sugar tolerance, without any arrest in growth (Fröhlich's syndrome) (fig. 871).

Another tumour which has to be differentiated is the glioma of the optic nerve. An X-ray should be taken to show the optic foramen, and if there is enlargement of one of these with corresponding primary optic atrophy in a child, such a tumour is suspected.

Mid-line cerebellar tumours (the medulloblastomata and ependymal tumours) are sometimes very difficult to distinguish from the cranio-pharyngiomata, especially if the X-ray shows no calcification. Irregular calcification is present, however, in about 85 per cent of these supra-sellar tumours and is a valuable confirmatory test.

Principles of Treatment. The surgeon is unable to remedy the abnormal pituitary function in these disorders. There remains, therefore, only one urgent indication for operation, and that is the commencement of papilloedema. The so-called adenomata of the pituitary continue to increase in size, and sooner or later such operative relief will become imperative.

It is important to realise that these tumours are not removed in the complete surgical sense. Complete removal would lead to a condition of pituitary inefficiency. The usual procedure is to incise the capsule over the bulging tumour and aspirate the contents with a sucker. The modern approach is through a right-handed transfrontal extra-dural pathway. This approach minimises the risk of subsequent speech disorders, hyperthermia, and mental confusion. A course of deep X-ray therapy may be tried for these pituitary cases in the absence of papilloedema, but is dangerous if compression is present. The patient should be under observation throughout, as symptoms may rapidly occur while the treatment is in progress, and urgent decompression may be called

for. The craniopharyngioma requires surgical treatment ; being mainly cystic it is not suitable for deep X-ray therapy. These cysts are in a very inaccessible region, and complete removal is very hazardous. The anterior communicating artery of the circle of Willis lies in intimate relation to the cyst wall in front, while the carotid vessels lie on either side. The usual treatment is to puncture the cyst and aspirate its contents and then to try to remove the cyst wall piecemeal. If the cyst is very large, puncture and sudden decompression may cause very unpleasant symptoms from sub-thalamic interference—hyperthermia, coma, etc.

ACOUSTIC NERVE TUMOURS

Neuromata. These tumours, which usually occur in middle age (30–50 years), produce a characteristic syndrome. The tumour commences in the neurilemmal sheath of the auditory nerve at the internal auditory meatus and grows steadily, expanding at the expense of the local structures (fig. 872). The tumour may reach a large size before the correct diagnosis is reached. The signs are most commonly as follows, and appear in this order :

- (1) Deafness, tinnitus, and vertigo ; these progress steadily.
- (2) Pain in the neck and suboccipital region.
- (3) Signs of cerebellar involvement—staggering gait and inco-ordination—(things may be dropped from the patient's hands, etc.).
- (4) Facial spasm, irritation, and weakness. Diplopia. Paræsthesia of the 5th nerve.
- (5) Difficulty in swallowing and in speech.
- (6) Signs of general rise of intra-cranial tension.

From the above it will be seen that at first the diagnosis is very difficult, whilst later it becomes obvious. In the early periods nearly all the patients are treated as "aural" cases, and in many aural lesions may co-exist. The differential diagnosis is from a variety of conditions, otosclerosis, toxic neuritis, labyrinthitis, senile deafness, chronic arachnoiditis, cerebellar lesions, pontine tumours, and meningioma along the lateral sinus. In generalised neurofibromatosis, acoustic nerve tumours may be found, and are then not infrequently bilateral (fig. 872). An X-ray may show excavation of the internal auditory meatus or flattening of the petrous bone.

Treatment. The tumour is explored by the suboccipital route. The cerebellar hemisphere is gently retracted, or if necessary a portion of it is amputated and the cerebello-pontine angle exposed. The tumour is pinkish-grey and lies closely applied to the petrous portion of the temporal bone. An arachnoid cyst is frequently found in front of the tumour and the surgeon must traverse this to expose the tumour. Numerous vessels run over the surface of the tumour and blend with the capsule. The 5th, 7th, and 9th, 10th and 11th cranial nerves

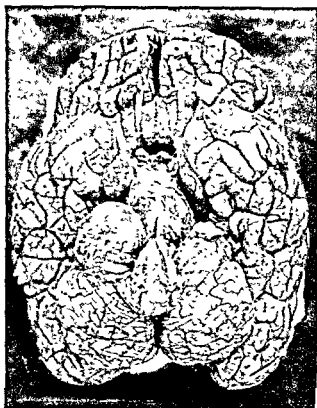


Fig 872.—PHOTOGRAPH OF BRAIN SHOWING BILATERAL ACOUSTIC NERVE TUMOURS. (Dr. L. Minski's case.)

are stretched out by the tumour and may also blend with the capsule. It is for this reason that complete removal of the tumour is impossible.

The present day procedure is to incise the capsule, and with a curette remove the contents, which are usually very soft and easily removed. This allows the capsule to collapse with complete relief of pressure symptoms. The acoustic nerve, however, usually remains paralysed. A subsequent course of irradiation may be given.

Angiomata. True angiomatous tumours form a small but definite entity in a very large series of intra-cranial neoplasms. It is, of course,

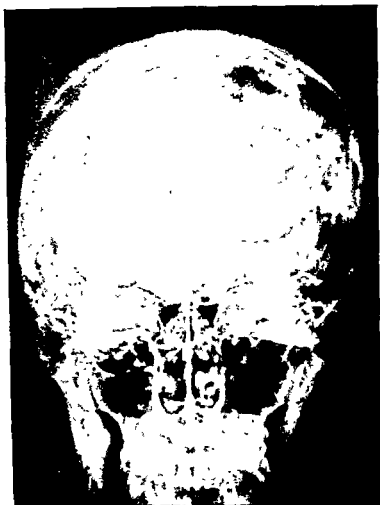


Fig. 873.—ANTERO-POSTERIOR SKIAGRAM OF SKULL SHOWING LARGE ANEURYSM OF THE OCCIPITAL CORTEX ON THE LEFT SIDE.

not uncommon to find large groups of vessels in the more vascular gliomata (figs. 873 and 874).

The angiomas have been divided into two main types :

- (1) The angiomatous malformations due to abnormal development of the cerebral vessels. These may be chiefly capillary (cerebral telangiectases), venous, or arterio-venous. These tumours are not infrequently associated with facial cutaneous nævi. The arterio-venous tumours may cause a bruit which is audible both to patient and surgeon. Unilateral exophthalmos and papilloedema may be associated.
- (2) The other type is the tumour known as the angioblastoma. These tumours are often cystic. They are found almost invariably in the cerebellum at the posterior end of the roof

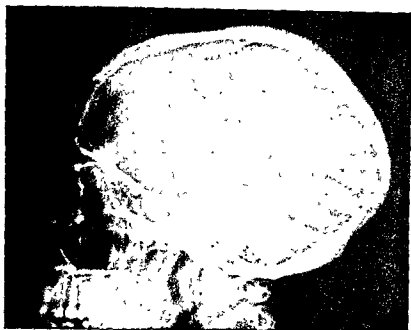


Fig. 874.—*LATERAL SKIAGRAM OF SKULL SHOWING ANGIOMA OF THE OCCIPITAL CORTX. THE VASCULAR MARKINGS OF THE SKULL ARE BOTH INCREASED AND ENLARGED. A DEFINITE BRUIT WAS AUDIBLE OVER THE LEFT OCCIPITAL REGION.*

of the fourth ventricle. These are the tumours which may be associated with angiomatosis of the retina (Lindau's disease) (fig. 875).

The first type of tumour should be treated by a surgical exploration, and perhaps cautery or occlusion with clips of any main vessels, followed by irradiation. It is impossible to remove the "tumour" completely. The hemiangiomablastomata, on the other hand, may be extirpated surgically, though bleeding may be troublesome during removal.

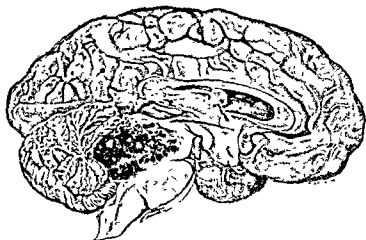


Fig. 875.—*MESIAL SECTION OF A BRAIN SHOWING DEEP SEATED ANGIOMA OF THE CEREBELLUM.*

From the preceding paragraphs the reader will realise that the surgery of the cranial cavity is still very imperfect, and that results are often disconcerting and disappointing. It has, however, to be remembered that this branch of surgery is of recent development, and that big advances are confidently to be expected. Diagnosis will become more accurate and reliable, methods of access will be improved, and technique standardised and comparable. In any case, it has to be remembered that the surgery of other forms of tumours is not entirely faultless. The mortality of craniotomy operations has been steadily reduced, and the present-day mortality is due less to the operation than to the severity of the lesion calling for relief. Patients are relieved from blindness, headaches, etc., and many are as completely cured as the patient who undergoes a radical operation for carcinoma elsewhere.

CHAPTER III

TECHNIQUE OF BRAIN OPERATIONS

CEREBRAL operations require a definite and special technique, which, if followed, reduces the mortality of such operations to a minimum. Nowadays, the neurological surgeon can often remove tumours from the brain with as much success as the abdominal surgeon removes tumours from the abdominal cavity. Naturally, some tumours are inoperable, e.g. those growing in the brain stem and basal nuclei, but for these much can be done by a decompression operation followed by a course of radio-therapy.

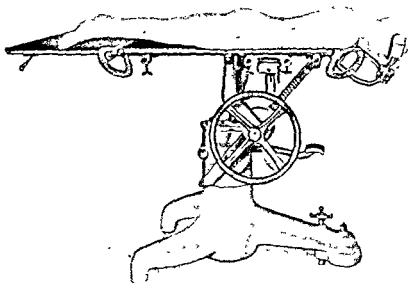


Fig 876 — POSITION OF PATIENT FOR CEREBELLAR DECOMPRESSION.

Although many different operating tables for brain operations have been designed, the standard pattern with its special fittings (figs. 876 and 877), manufactured by Allen & Hanburys, fulfils all necessary purposes. It is important that the head should be firmly fixed, and this may be attained by using the special head clamp, which is protected with 2-inch sorbo rubber and maintains any position excellently

(fig. 877). There is no essential difference between the pre-operative preparation for a cerebral operation and that for an abdominal operation, with the exception of those cases where the intra-cranial pressure is very high, in which case it is advisable to inject a hyper-tonic saline solution intravenously. Drastic purgation must be avoided, and the patient should be encouraged to drink plenty of fluid for twenty-four hours prior to the operation. The scalp is a difficult part of the body to cleanse, owing to the presence of numerous

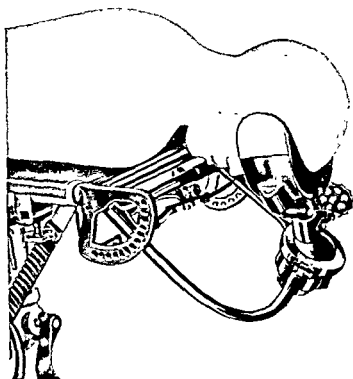


FIG 877.—DIAGRAM SHOWING SPECIAL HEAD CLAMP AND PATIENT IN POSITION FOR A CEREBELLAR EXPOSURE.

sweat glands, the ducts of which all harbour staphylococci in abundance. The scalp must be shaved, and after being washed with ether soap and water, a spirit compress should be applied. The whole head should be shaved in a man; in a woman this is not absolutely necessary, although in the latter case an area two inches at least beyond the line of the proposed incision must undergo similar careful preparation.

ANÆSTHESIA

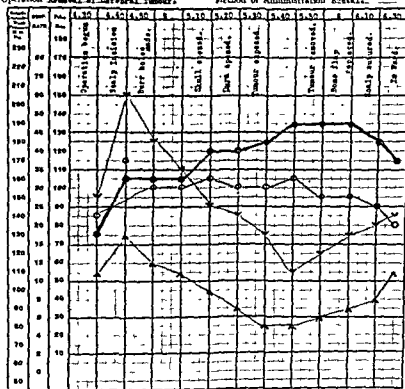
The problem of the best form of anæsthesia in brain operations no longer exists, as local anæsthesia has become a routine. This accounted

form of anaesthesia has resulted from experience gained during the Great War, when thousands of head cases were treated, and also from the example set by Harvey Cushing in America. Avertin anaesthesia is now always employed, followed by intra-tracheal gas and oxygen, the scalp being anaesthetised with $\frac{1}{2}$ per cent novocaine. Frequently

WEST END HOSPITAL FOR NERVOUS DISEASES.

ANAESTHESIA CHART.

Name John J. Jones Blood Pressure S. 150. D. 105.
 Age 45 Surgeon Mr. Cecil F. G. Wakeley
 Ward W. 3. Anaesthetic Ether and Local
 Date of Operation 20.1.20. Amount 3 IV.
 Operation Removal of Cerebral Tumour. Method of Administration Rectal.



CODE: P PULSE RATE. R RESPIRATION RATE. S SYSTOLIC AND DIASTOLIC BLOOD PRESSURE.
 Preliminary Drugs Atropine, Gr. 1/100
 Induction Smooth
 Subsequent anaesthesia Smooth
 Condition on leaving Operating Theatre Satisfactory
Frank H. Jones Anaesthetist.

Fig 878.—OPERATION CHART TAKEN DURING THE REMOVAL OF A MENINGIOMA OF THE BRAIN.

no gas and oxygen are given at all, but it is useful to have the intra-tracheal catheter *in situ* during the operation in order that oxygen or carbon dioxide can be given at any moment should the surgeon think it advisable; further, by its means any mucus which may collect in the trachea can be removed by a suction apparatus. The local infiltration of novocaine has two great advantages in that it lessens the shock caused by the scalp incision and, what is more important, it renders

the scalp tissues œdematous and thus facilitates control of the scalp vessels with artery forceps. Deep anæsthesia is not required during cranial operations, the scalp being the only sensitive tissue; the local infiltration of novocaine prevents painful stimuli reaching the brain. The bone and dura mater are insensitive, except along the attachment of the latter to the base of the skull. At times the surgeon is called upon to operate on comatose patients, and in these cases local infiltration is the only form of anæsthesia required.

A chart recording the pulse, respiration, and blood-pressure should be kept by the anæsthetist throughout the whole operation (fig. 878). Such a record will prove of great service to the surgeon, as it will provide an invaluable guide regarding the condition of the patient at any moment. The surgeon should so plan his operation as to provide sufficient exposure of the intra-cranial area without ultimately producing disfiguring scars, and at the same time preserving as far as possible the blood supply to the scalp and to the bone flap.

As a rule, supra-tentorial tumours are exposed through osteoplastic flap craniotomies, while the infra-tentorial tumours are explored through suboccipital decompressions, the bone in the cerebellar fossæ being so thin that osteoplastic flaps cannot be cut. For those tumours which are situated in the region of the cerebello-pontine angle, a combined supra- and infra-tentorial exposure may be required. Great care should be taken to reduce hæmorrhage to an absolute minimum throughout the operation. In the past many a patient has suffered severe shock before the osteoplastic flap has been raised, owing to the amount of blood lost by the incision into the scalp. The best method of controlling hæmorrhage from the scalp is to use curved-pointed artery forceps which can pick up any bleeding vessel and at the same time pick up the galea. The forceps are then turned over the edge of the scalp, and there serve as an excellent compressor to the scalp, preventing any oozing throughout the operation. Scalp forceps which compress the whole thickness of the scalp are not recommended, as they traumatise the scalp and also obstruct the field of operation to a much greater extent than is the case with the simple procedure described above. The handles of the artery forceps can be maintained in a convenient position by including ten or a dozen in a thin rubber band.

For making an opening in the skull, a burr is far superior to a trephine. For this purpose a Hudson brace and burrs will be found to be the most satisfactory (fig. 879). After the number of burr holes, depending on the size of the osteoplastic flap, have been made, the dura mater

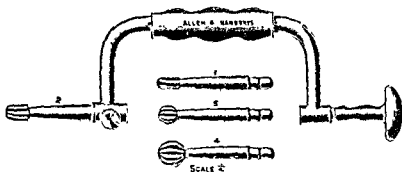


Fig. 879.—HEDDON'S BRACE AND BURRS.

must be separated from the skull in the region of the opening. The best instrument for this purpose is an Adson dura mater separator (fig. 880). The dura mater having been detached from the inner table



Fig. 880.—ADSON'S DURA MATER SEPARATOR.

of the skull, the next procedure is to unite the openings, which can be done most effectively by means of a Gigli saw. Some surgeons, however, prefer to use a hand-saw ; for this purpose the saw is held in such a position as to produce a bevel on the cut edges of the bone flap.



Fig. 881.—GIGLI SAW GUIDER SHOWING THE METHOD BY WHICH THE LOOPED END OF THE SAW IS ATTACHED TO IT.

When a Gigli saw is used it is threaded on to a metal guide (fig. 881), which is passed through one burr opening and is then so manipulated as to emerge at another (fig. 882). The guide is pushed through the exit hole to a distance sufficient for the saw to be unhooked. Metal handles are then affixed at either end of the saw and the surgeon saws through the skull by pulling the wire saw to and fro ; the metal guide, which is still between the skull and the dura mater, prevents any injury

more simple of the two, and consists of withdrawing some cerebro-spinal fluid by means of lumbar puncture and introducing air, which, by slowly ascending the theca, will give an outline of the ventricular system of the brain in an X-ray picture. The cerebro-spinal fluid pressure should always be measured with the Greenfield manometer (see page 1842). Encephalography may cause violent headache, and at times vomiting, but this can be reduced to a minimum if the

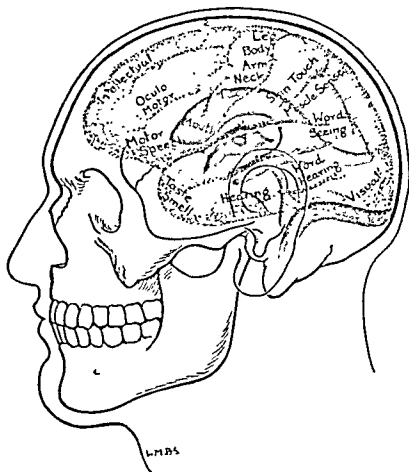


Fig. 885.—DRAWING SHOWING THE OUTLINE OF THE VENTRICLES TO THE SURFACE OF THE SKULL. ALSO THE DIFFERENT AREAS OF THE BRAIN THAT COME INTO RELATION TO THE VENTRICULAR SYSTEM.

cerebro-spinal fluid is withdrawn slowly in small amounts (5 cc.), and a correspondingly small amount of air is introduced slowly. Generally 20 to 25 cc. of air can be introduced by this means, and after an hour X-rays are taken of the skull in the antero-posterior and lateral positions. The outlines of the ventricles can usually be seen and any abnormality noticed.

Encephalography cannot be used when there is any increase in the cranial pressure, and as the majority of cerebral tumours cause a finite increase of this pressure, its use is mainly in patients with

inserted, and the incision extended in any desired direction. Any bleeding from cortical vessels may be controlled by means of metal clips or by the coagulation current, or, as a last resort, with a piece of muscle which can usually be obtained from the base of the osteoplastic flap, for, as a general rule, the flap is made to hinge on the temporal muscle. A small piece of living muscle pressed on to a bleeding surface for a minute or two has a marvellously rapid hæmorrhagic effect which must be seen to be realised.

If a cortical tumour is exposed, the further treatment will depend on the type of tumour and its extent. The greatest boon to the neurological surgeon to-day is the electro-surgical unit, as Harvey Cushing has so ably demonstrated. This apparatus has probably contributed more to the treatment of cerebral tumours than anything else, for it has made possible the removal of tumours which were formerly considered inoperable owing either to their inaccessibility or to the impossibility of controlling hæmorrhage when removed by ordinary dissection.

The closure of the wound after the exploration of a cerebral tumour is a very important part of the operative technique. In those cases where removal is impossible, the bone flap should be removed, the scalp closed, and when union has taken place, some post-operative X-ray therapy given. It is most important that no form of radio-therapy should be given through an intact skull, as the effect of this treatment is to cause some œdema of the underlying brain, and in cases where the intra-cranial pressure is already high the results may be fatal. In cases where a tumour has been removed, the osteoplastic flap is replaced and retained in position by interrupted silk sutures passed through the periosteum. The muscles, fascia, galea and skin are carefully sutured by interrupted silk sutures. Drainage is very rarely necessary, but should it be, some untied sutures must be inserted at the time of the operation and tied when the drainage-tubes are removed. The dressings should be adequate and retained by firm bandages. Drops of castor oil should be instilled into each eye. As the bandage encircles the ears, it is a useful practice to apply sterile vaseline in front and behind the ears prior to the application of the bandage. This saves the patient a considerable amount of pain and discomfort; it is a small point, but of definite practical importance.

ENCEPHALOGRAPHY AND VENTRICULOGRAPHY

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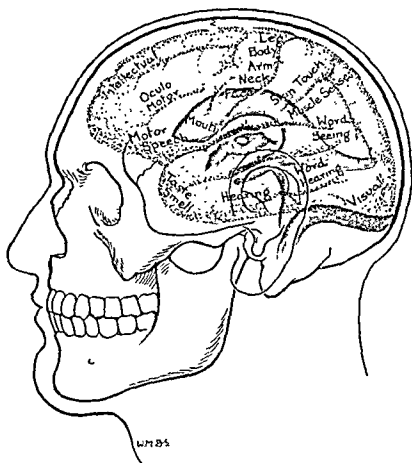


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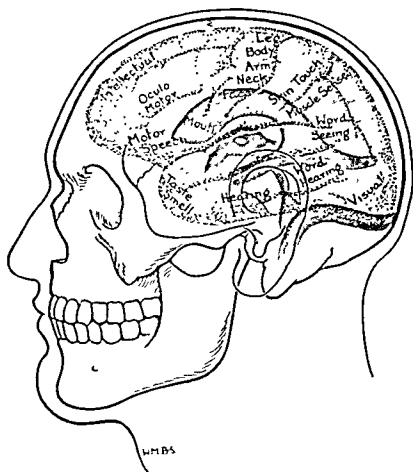


Fig. 825.—DRAWING SHOWING THE OUTLINE OF THE VENTRICLES TO THE SURFACE OF THE SKULL. ALSO THE DIFFERENT AREAS OF THE BRAIN THAT COME INTO RELATION TO THE VENTRICULAR SYSTEM.

cerebro-spinal fluid is withdrawn slowly in small amounts (5 cc.), and a correspondingly small amount of air is introduced slowly. Generally 20 to 25 cc. of air can be introduced by this means, and after an hour X-rays are taken of the skull in the antero-posterior and lateral positions. The outlines of the ventricles can usually be seen and any abnormality noticed.

Encephalography cannot be used when there is any increase in the intra-cranial pressure, and as the majority of cerebral tumours cause a definite increase of this pressure, its use is mainly in patients with

sequelæ of intra-cranial trauma, or in cases of suspected cerebral tumours where the intra-cranial pressure is normal.

Ventriculography is a more formidable procedure, and involves two incisions and two perforations of the skull. However, this method must remain the method of choice in the majority of cases of unlocalised brain tumours, as in the majority of these cases there are signs of increased intra-cranial pressure.

The neurological surgeon must have a sound knowledge of the topography of the ventricular system of the brain (fig. 885), otherwise ventriculography will be a difficult operation and a fatal result may ensue.

The technique of ventriculography consists of making two small incisions in the scalp, about one inch on either side of the mid-line, and about two inches above the lambdoid suture. Local anæsthesia with $\frac{1}{2}$ per cent novocaine is quite sufficient for this operation. The lips of the incisions are retracted and small burr holes are made. The dura mater when exposed is carefully nicked with a small crucial incision. The patient is usually placed in the sitting or semi-recumbent position, and it is important that the head should be securely fixed. A ventricular needle is introduced through the burr hole and passed downwards, forwards, and inwards, in such a way that the lateral ventricle is entered at the junction of the body with the occipital horn (fig. 886). The ventricular needle should be blunt, graduated in centimetres, and equipped with a three-way stopcock into which a 20 cubic-centimetre syringe is fitted. Fraser and Dott use oxygen instead of air for replacing the cerebro-spinal fluid (fig. 887), and this necessitates a little more apparatus, but as a rule air gives just as good results and is found to be absorbed from the ventricles just as easily as oxygen. It is advisable to inject air into one side only, as by so doing the patency of the foramen of Munro can be determined by the passage of air from one ventricle to the other. If no fluid can be obtained from one ventricle, the needle must be inserted into the ventricle on the opposite side. As much cerebro-spinal fluid as possible is withdrawn, and is then replaced by a somewhat smaller volume of air, except in cases of marked internal hydrocephalus. The average amount of air to be injected is between 50 and 120 cubic centimetres.

When the air has been injected the wounds are closed and the patient is transferred to the X-ray department. Lateral and antero-posterior skiagrams are taken; a Potter-Bucky diaphragm should be used as better results can thus be obtained.

The lateral skiagrams may show deformity of the anterior or

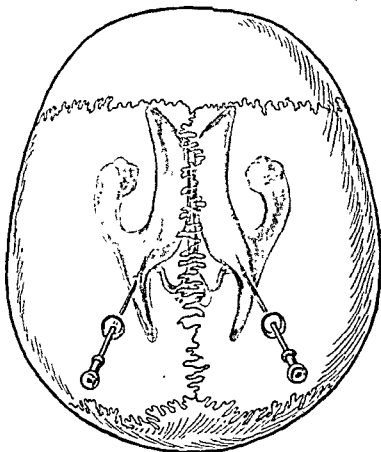


Fig. 896.—DIAGRAM SHOWING THE VENTRICULAR SYSTEM OF THE BRAIN FROM ABOVE. IT SHOWS THE POSITION OF THE VENTRICULAR PUNCTURE.

posterior horns by tumours situated in the frontal or occipital regions. The antero-posterior skiagrams may show a deflection of the ventricles from the mid-line or a filling defect of the third ventricle. The normal appearance of the ventricles, as seen in an antero-posterior view, is

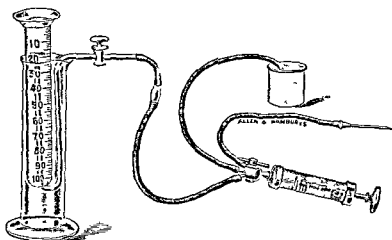


Fig. 887.—THE FRASER AND DOTT VENTRICULOGRAPHY APPARATUS. THE OXYGEN IS WITHDRAWN FROM THE INVERTED JAR OVER WATER.

shown diagrammatically in figure 888. It must always be remembered that encephalography and ventriculography are only adjuncts to neurological diagnosis, and are not required in the majority of cases of cerebral tumours where localisation is established on clinical grounds.

Ventricular Estimation. This is a much simpler and safer procedure than ventriculography, and consists of tapping both lateral ventricles and not injecting air. Asymmetry of the lateral ventricles is in itself

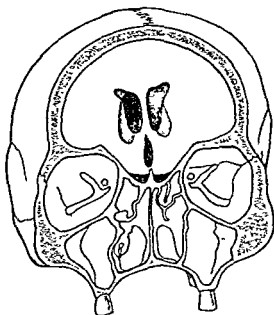


Fig 888.—DIAGRAMMATIC SECTION THROUGH THE SKULL AND BRAIN SHOWING THE POSITION OF THE VENTRICLES AFTER VENTRICULOGRAPHY.

strong evidence of a cerebral tumour on the side of the smaller ventricle; further, a symmetrical hydrocephalus usually indicates a cerebellar tumour. These facts, taken with the clinical neurological signs, will usually suffice to localise a tumour. It follows that in cases of doubt a ventriculography should be performed.

REMOVAL OF BRAIN TUMOURS

From the surgical standpoint tumours of the brain may be divided into two large groups, the one including the encapsuled and accessible infiltrating tumours, and the other all diffuse, infiltrating, inaccessible tumours.

The encapsuled accessible tumours (fig. 889—meningiomata and neurofibromata) lend themselves to complete surgical removal, while the infiltrating tumours (gliomata), when situated in a silent area, can also be removed by including that part of the brain which surrounds it. However, the surgeon must not let technique triumph over reason in this respect. Wholesale ablation of lobes of the brain which leaves the patient a hopeless, aphasic, incontinent hemiplegic is rightly condemned. A properly placed adequate decompression, followed by radio-therapy, will give much better results, while at the same time more normal function is preserved.

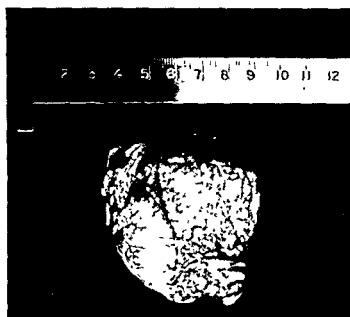


Fig. 889.—MENINGIOMA REMOVED FROM LEFT FRONTAL LOBE OF THE BRAIN.

Transfrontal Operations. The transfrontal route is commonly used for tumours of the pituitary and for supra-pituitary cysts (cranio-pharyngiomata and meningiomata).

The patient should be in the supine position with the head slightly extended over a sand-bag. An ear-to-ear incision is made, starting about 2 cm. above and in front of the ear and passing transversely across the head to the other side (fig. 890). The scalp is turned forwards over the face, the supra-orbital vessels and nerves being preserved. An osteoplastic flap is elevated outwards, the temporal muscle acting as a hinge (fig. 891). An X-ray of the skull will enable the surgeon to avoid opening the frontal sinus, but for complete exposure it is essential that the lower border of the flap should be as low as possible.

In some cases where a large meningioma occupies the whole of one



Fig. 892.—INCISION FOR TRANSFRONTAL OPERATIONS.

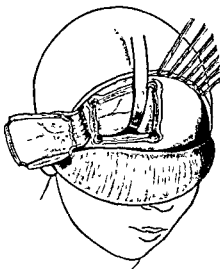


Fig. 891.—TRANSFRONTAL OPERATION SHOWING THE REFLECTION OF THE OSTEOPLASTIC FLAP.

frontal lobe and part of the other (fig. 892), it is necessary to make such a large osteoplastic flap that both frontal lobes are exposed (fig. 893). In this case the bone is turned forwards.

The next step is to elevate the dura mater from the orbital roof and keep it retracted by means of a retractor (see fig. 891). A very

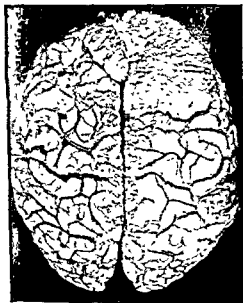


Fig. 892.—PHOTOGRAPH OF BRAIN SHOWING VERY LARGE RIGHT FRONTAL MENINGIOMA EXTENDING OVER TO THE LEFT FRONTAL LOBE.

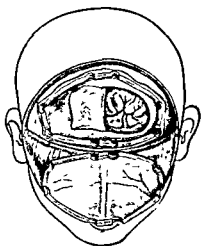


Fig. 893.—TRANSFRONTAL OPERATION FOR EXPOSURE OF BOTH FRONTAL LOBES OF THE BRAIN.

useful retractor which also combines suction and illumination is depicted in figure 894. The amount of room at the disposal of the surgeon is not very great. Consequently, if one instrument serves the purpose of three, it will prove more satisfactory. The dura mater is gradually and very carefully separated by means of small rolls of cotton wool, until the ridge of the lesser wing of the sphenoid is reached. On the medial side the separation is limited by the olfactory groove.

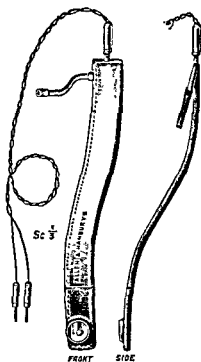


Fig. 894.—THE WAKELEY-RAWLING ILLUMINATED RETRACTOR AND SUCKER.

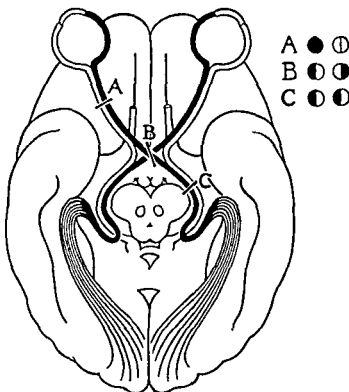


Fig. 895.—THE CONNECTIONS OF THE OPTIC NERVES SHOWING HOW LESIONS AT A, B, AND C WILL BE EXHIBITED ON THE FIELDS OF VISION.

- A. TOTAL BLINDNESS OF LEFT EYE.
- B. BITEMPORAL HEMIANOPIA.
- C. LEFT HOMONOMOUS HEMIANOPIA.

The dura mater is incised at the limit of separation and the cerebrospinal fluid allowed to escape. The illuminated retractor is now inserted through the opening in the dura mater and beneath the frontal lobe of the brain, and is then carefully and slowly retracted when the right optic nerve will generally come into view (fig. 895). The olfactory tract can sometimes be seen as it lies on the inner side of the field of operation. As a result of the pressure of the tumour the optic nerve may be flattened. In cases of pituitary tumour which have not been subject to surgical interference, the optic nerves may be so flattened that they look like broad strands of tissue (fig. 896). The pituitary

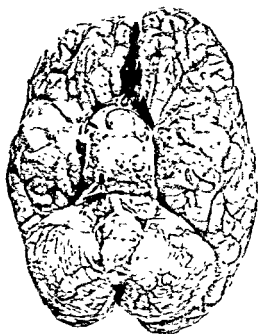


Fig. 896.—PHOTOGRAPH OF BRAIN SHOWING LARGE PITUITARY TUMOUR CAUSING FLATTENING OF OPTIC CHIASMA AND OPTIC NERVES.



Fig. 897.—PHOTOGRAPH AFTER OPERATION OF A PATIENT WHO HAD A MENINGIOMA REMOVED FROM THE FRONTAL REGION.

tumour will be seen to the inner side of the optic nerve, and the internal carotid artery may sometimes be seen lying to the outer side of the optic nerve.

When the tumour is adequately exposed a needle is inserted into it in order to discover if it is cystic; should this be the case, some fluid must be withdrawn, as this will create more space for the complete removal of the tumour. In cystic tumours, withdrawal of fluid causes the capsule to collapse so that it can be removed by gentle traction.

When the tumour is solid, as in the case of an adenoma of the pituitary, the capsule of the tumour is incised with the diathermy needle and the interior of the tumour is aspirated or removed by means of a small metal loop. The capsule is then gradually removed by careful traction. Hæmorrhage may be controlled by means of small rolls of cotton wool and a gentle stream of hot saline solution. To be certain that all the tumour capsule is removed is wellnigh impossible in every case, and for this reason it is advisable to give a course of X-ray therapy after the operation.

Cranio-pharyngeal cysts are always above the sella turcica and are exposed in a similar way; the cyst is punctured, the fluid withdrawn, and the capsule removed by firm traction.

Supra-sellar meningiomata are usually very vascular, and when

exposed removal can only be effected by an electrical loop attached to a diathermy apparatus.

The closure of the wound after a transfrontal operation is quite simple. The bone flap is replaced, the periosteum sutured (where possible with interrupted silk sutures), and the scalp flap replaced and sutured in the usual way. There is no visible scar after this operation, as may be seen in figure 897.

Trans-sphenoidal Exposure of Pituitary Tumours. This operation is seldom performed to-day, its only indication being in a case of acromegaly (fig. 898). Such a case is usually treated by the insertion of radon seeds into the pituitary adenoma by the transfrontal route.

Intra-tracheal anaesthesia is essential in this operation, and the patient should be in the supine position with the head well extended. The frenum of the upper lip is incised and the lip retracted upwards with a periosteal elevator; the muco-periosteum is then displaced upwards until the anterior edge of the nasal septum is exposed. A submucous resection of the nasal septum is now performed, and the sphenoidal attachment of the vomer exposed and removed. By means of a lighted speculum the anterior walls of the sphenoidal sinuses can

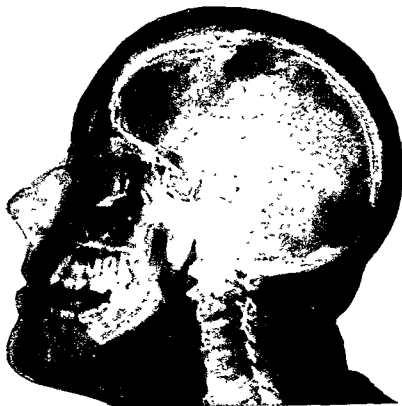


Fig. 898.—SKIAGRAM OF SKULL OF ADVANCED ACROMEGALIC. THE ENLARGED SELLA TURCICA CAN BE SEEN AND THE OVER DEVELOPED LOWER JAW.

be seen, and the thin bone which constitutes these walls, together with the thin vertical septum separating the two sinuses, can then be removed by long thin alligator forceps, thus exposing fully the cavity of the sphenoidal sinuses (fig. 899). The bulging floor of the sella turcica, which forms the roof of the sphenoidal sinuses, can now be seen and this is broken through, exposing the dura mater covering the tumour. The dura is incised with a long, thin, hooked knife, and the

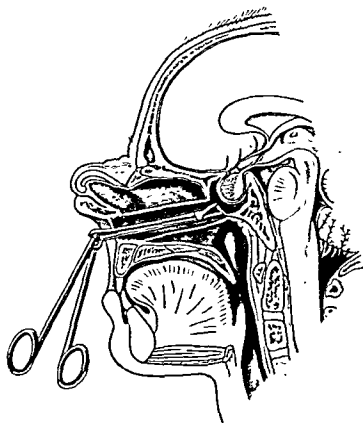


Fig. 899.—*Diagrammatic drawing showing the Trans-sphenoidal Operation for Pituitary Adenoma.*

tumour contents can be seen discharging into the cavity of the sphenoidal sinuses. As much as possible of the softish tumour substance is removed by suction.

Drainage is carried out by inserting a thin strip of rubber into the sella turcica and allowing it to lie between the muco-periosteal layers of the nasal septum and fixing it to the frenum of the lip. The rubber strip should be removed after an interval of thirty-six hours. The nasal cavities are plugged with gauze soaked in vaseline which should be removed twenty-four hours after the operation. The patient should be nursed in the Fowler position.

Operations on the Cerebral Hemispheres. The two common tumours which are met with in the hemispheres are meningiomata and gliomata. Space forbids a detailed description of the various exposures which should be made for the removal of these tumours. Osteoplastic flaps are used whenever possible. For exposures of the fronto-parietal

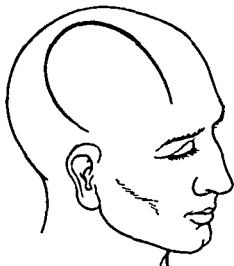


Fig. 900.—THE EXTENT OF THE FLAP INCISION FOR EXPOSURES OF THE FRONTO-PARIETAL AND TEMPORAL REGIONS.



Fig. 901.—EXTENT OF INCISION IN A CASE OF LARGE PRE-ROLANDIC GLIOMA

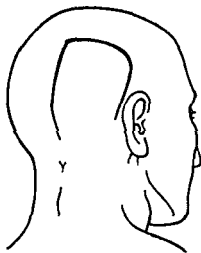


Fig. 902.—FLAP INCISION EXPOSING THE OCCIPITAL LOBE OF THE BRAIN.

and temporal regions, the incision shown in figure 900 is used. The flaps must of necessity be placed so as to suit each individual case. Figure 901 shows the extent of the scalp flap in a case of a glioma in the pre-Rolandic area, which was successfully removed. In such incisions the only part which can be seen after recovery from the operation is in the mid-line of the forehead, as the hair when it grows

completely hides the rest of the scar. In cases of tumour of the occipital lobe, the flap incision is made so as to include the occipital artery (fig. 902).

Meningiomata. These tumours are very suitable for complete removal, the chief difficulties they present being in their situation and their vascularity. They may be classified into three groups :

- (1) Those associated with the large venous sinuses, more especially the superior longitudinal (sagittal) and lateral (transverse) sinuses.
- (2) Those which develop in the fossæ of the skull beneath the brain.
- (3) Those which develop on the surface of the brain and which are usually flattened plaques.

Meningiomata, formerly called endotheliomata, of the dura mater are now known to grow from arachnoid villi and, histologically, often tend to psammoma formation (fig. 903). Their characteristic features



Fig 903—MICROPHOTOGRAPH OF MENINGIOMA SHOWING PSAMMOMA FORMATION.

are slow growth and a rounded encapsuled appearance. They are usually single, and vary in size from that of a pea to that of a grape fruit. At times they are small, flat plaques, and this is especially the case with those which develop on the surface of the brain. They may undergo malignant change. Although these tumours originate in the arachnoid mater and are invariably adherent to the dura mater, for their complete removal it is necessary to remove the adherent dura mater with the tumour.

These tumours also tend to involve the overlying bone. An X-ray examination will often demonstrate the infiltration of the skull with tumour tissue (fig. 904). When an osteoplastic flap has been turned down, should there be any doubt as to whether or no the bone is



Fig. 904.—PARA SAGITTAL MENINGIOMA INVOLVING THE SKULL ON EITHER SIDE OF THE LONGITUDINAL SINUS.



Fig. 905.—SKIAGRAM SHOWING HYPERTROPHIED BONE OVERLYING A PARA SAGITTAL MENINGIOMA.

involved, all that is necessary is to remove the bone, boil it for half an hour, and then keep it in normal saline until the tumour itself has been removed, when the bone may be replaced and the scalp sutured over it.

Para-sagittal Meningiomata. As their name suggests, these tumours are usually confined to one or other, or to both sides of the falx cerebri. The tumour commences on one side of the falx and may extend after a long time through the superior longitudinal (sagittal) sinus to the other side. In these cases, the overlying skull is frequently hypertrophied (fig. 905), a condition which can be determined by clinical and X-ray examination. The hypertrophied bone is always invaded with tumour cells, and this fact must always be taken into account in planning the surgical approach for the removal of the tumour.

As these tumours are frequently very vascular, it is always a wise precaution to have the patient's blood grouped, and have a donor in readiness in order that a blood-transfusion can be given at any time during the operation. It is also advisable to have the outer side of one buttock sterilised to make provision for a flap of muscle to be cut out should this be necessary for arresting hæmorrhage. A large osteoplastic flap is turned outwards, bleeding from the tumour controlled by hot swabs, and that from the bone by Horsley's wax. If there is any increase in intra-cranial pressure, ventricular puncture will have a very beneficial effect on the bleeding. The dura mater is incised well outside the margins of the tumour, and any bleeding vessels encountered are controlled with metal clips or the electro-coagulating current.

When the dural incision is complete, slight but firm traction on it will reveal the extent of the tumour which is often embedded in the substance of the brain. With the use of small rolls of wool, soaked in hot saline solution, and the point of the diathermy cautery, the tumour can be dislodged without much hæmorrhage. If the tumour is very large it is often a better plan to gouge out its interior with an electro-surgical loop. As the result of such treatment the tumour shrinks up and its complete removal presents little difficulty.

If the tumour is situated on both sides of the longitudinal sinus, and is anterior to the lateral communicating veins, the whole tumour with the falx and the sinus may be resected without producing motor or sensory paralysis. If, however, the tumour is placed posteriorly to the lateral communicating veins, removal of the longitudinal sinus will result in paralysis, and therefore this structure should be carefully preserved, although complete removal of the tumour may thereby be

rendered impossible. In such cases post-operative radiation therapy should be given with the object of completely destroying any tumour cells. In cases where a large hypertrophied osteoma of the skull overlies a para-sagittal meningioma, the surgeon can trim off the hypertrophied bone, boil the newly-fashioned bone flap for half an hour, and then replace it.

At times, meningiomata may arise on the tentorium, in which case they must be resected with that structure. If bleeding cannot be stopped with the ordinary methods, a muscle flap can be cut and applied to the cavity from which the tumour has been removed. Vivocol, a hæmostatic agent, has been found to be most useful for completely arresting the hæmorrhage in some cases where other methods have failed.

Basal Meningiomata. These tumours may be met with in any one of the three fossæ at the base of the skull, but are most commonly found in the anterior fossa. They behave very similarly to those which develop in connection with the sinuses, and often produce exostoses in the floor of the skull. The common places for their development are the olfactory grooves, the anterior crest of the sella turcica, and the lesser wings of the sphenoid. They may grow to a very large size before they give rise to any symptoms, and they tend to become calcified.

The pre-frontal meningiomata are approached through a trans-frontal route (see page 1807), those situated in the temporal fossa through a large musculo-cutaneous, sub-temporal, decompression craniotomy (see page 1818), and basal meningiomata which arise in the posterior fossa through a bilateral suboccipital craniotomy (see page 1819).

Meningiomata developing on the surface of the brain represent the smallest group of encapsulated tumours. They are easily removed and represent a group which can be treated surgically with the greatest hope of success. The methods of exposure and removal are very similar to those employed in the operative treatment of the para-sagittal meningiomata.

The gliomata form a large group of infiltrating tumours and are classified according to their histological structure. The most benign types are the oligodendrogliomata and the astrocytomata. These grow slowly, and have a tendency to undergo cystic degeneration. Such tumours may occur at any age and in any part of the brain.

The common malignant type of glioma is the spongioblastoma

multiforme—a vascular tumour which tends to grow rapidly and has no marked tendency to undergo cystic degeneration.

The most malignant type of the glioma group is the medulloblastoma, for which little can be done surgically.

Taken as a whole, the glioma group of tumours do not give very satisfactory results from surgical treatment. It is true that such extensive operations as resection of a cerebral hemisphere have been performed in the past, but it is a moot question whether such operations are justifiable or not. Gliomata, which are situated in the silent areas—pre-frontal region—of the brain, can be removed with the surrounding brain by means of the diathermy knife. Those which occur in the region of the motor area can often be removed by aspiration. The larger gliomata have a tendency to undergo cystic degeneration, and the opening up of a cyst may provide convenient access to a deeply placed tumour. Hæmorrhage must be controlled by means of electrical coagulation. A large decompression area must be left in these cases, in order that post-operative X-ray treatment can be given at a later period.

Sub-temporal Decompression. This operation is designed to relieve increased intra-cranial pressure by providing a large hole in the meninges and skull wall, through which the brain may protrude. In many cases it relieves headaches and vomiting and prevents loss of sight, but it must be looked upon as an operation which affords only temporary relief in cases of cerebral tumour. Nowadays, this operation is restricted to deep-seated infiltrating tumours which cannot be exposed or removed through an osteoplastic flap exposure. In some cases it may be necessary to perform the operation on both sides.

In this operation a flap is not required, but a vertical incision is made just above the ear, extending upwards to the mid-line. The incision can be carried right down to the bone. The temporal fascia and underlying muscle are split in the line of the incision and so retracted as to expose the bone. The skull is perforated by a burr, and the opening so made is extended in all directions by the use of rongeur forceps. A large decompression can be made in the bone with but little damage to the temporal muscle. If the dura is very tense owing to great increase in the intra-cranial pressure, the lateral ventricle should be tapped before the dura mater is incised. The dura mater should be opened in a radiating manner, from about the middle of the decompressed area. The brain will bulge through the opening in the dura, and this membrane will prevent the brain from coming into

contact with the edges of the aperture in the skull. No attempt should be made to close the dura mater. The temporal muscle and fascia are united over the protruding brain by means of interrupted catgut sutures. The scalp is closed by interrupted silk sutures.

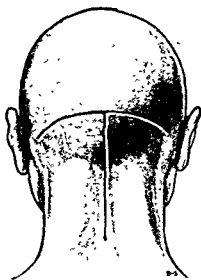


Fig. 906.—CROSS-BOW INCISION FOR CEREBELLAR EXPOSURE.

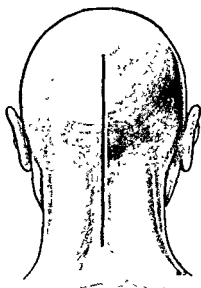


Fig. 907.—INCISION FOR CEREBELLAR OPERATIONS.

Cerebellar Operations. For these operations the patient is placed in the prone position as shown in figure 876. The surgeon will often find it advantageous to have the head end of the table raised and the other end lowered. There are two incisions, either of which will give satisfactory and adequate exposure of the cerebellar region. One, the so-called "cross-bow" incision, is shown in figure 906, and requires no explanation, while the other, which gives just as good an exposure in most cases and is the incision *par excellence* in children, consists of a vertical incision along the mid-line extending from well above the lambda to the spine of the seventh cervical vertebra (fig. 907). This vertical, mid-line incision heals up very quickly, the muscles come together without tension, and the resulting scar is negligible (fig. 908).



Fig. 908.—PHOTOGRAPH OF HEALED CEREBELLAR INCISION TWO WEEKS AFTER OPERATION.

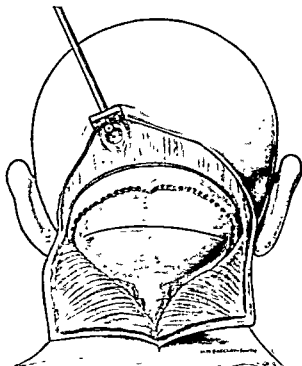


Fig. 909.—CEREBELLAR EXPOSURE THROUGH A CROSS-BOW INCISION. THE LATERAL VENTRICLE HAS BEEN TAPPED. THE LINE OF INCISION THROUGH THE BULGING DURA MATER CAN BE SEEN.

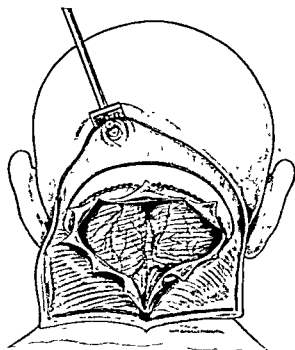


Fig. 910.—BILATERAL CEREBELLAR EXPOSURE THROUGH CROSS-BOW INCISION. THE DURA MATER HAS BEEN RETRACTED AND THE CEREBELLAR HEMISPHERES CAN BE SEEN.

If the "cross-bow" incision is made, the two scalp flaps are reflected downwards and outwards, and the muscles are detached from the occipital bone by means of a rugine.

Two burr holes are made in the posterior fossæ of the skull, and the bone surrounding the burr holes removed by curved rongeur forceps. Any bleeding from the bone, either from its cut surface or from emissary veins, is controlled by the application of Horsley's bone wax. If the intra-cranial pressure is very high, the posterior arch of the atlas is removed and the lateral ventricle is tapped by retracting the upper end of the scalp incision and making a small burr hole through which a ventricular needle can be passed (fig. 909). When the

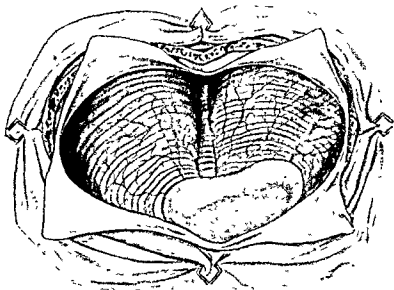


Fig. 911.—LARGE CEREBELLAR CYST WHICH IS PROTRUDING THROUGH THE DECOMPRESSION OPENING.

intra-cranial pressure has been so reduced that the exposed dura is no longer tense, it can be incised in a transverse manner and the cerebellar lobes exposed (fig. 910). The cerebellar hemispheres should be carefully palpated in order to discover any evidence of the presence of an underlying tumour. At times bulging of one of the cerebellar hemispheres or of the vermis indicates the presence of a tumour. When such is the case, an incision may be made with the diathermy knife over the bulging, and the tumour removed.

If nothing is found in the hemispheres themselves, the region of the cerebello-pontine region can be exposed by careful medial retraction of the cerebellar hemispheres, when the seventh and eighth nerves passing into the internal auditory meatus will come into view, and below these the ninth, tenth, and eleventh nerves passing out

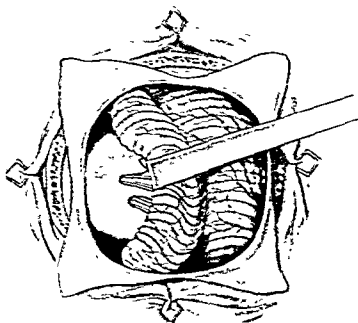


Fig. 912.—EXPOSURE OF CEREBELLO-PONTINE ANGLE. THE SEVENTH AND EIGHTH NERVES CAN BE SEEN ABOVE AND PASSING OUT THROUGH THE INTERNAL AUDITORY MEATUS. BELOW CAN BE SEEN THE SIXTH, TENTH, AND ELEVENTH CRANIAL NERVES.

of the posterior fossa through the jugular foramen (fig. 912). This exposure can be used for intra-cranial division of the eighth and ninth cranial nerves in cases of Ménière's Disease or of paroxysmal glossopharyngeal neuralgia.



Fig. 913.—INTERNAL AUDITORY MEATUS SHOWING LARGE ENLARGED TUMOUR ON THE RIGHT SIDE.

If an acoustic neuroma of the eighth nerve is exposed, the sheath of the tumour is incised and the contents removed by suction. The characteristic features of these so-called eighth nerve tumours is their very slow growth, and their general tendency to undergo fatty degeneration. These tumours are often of considerable size, and by their continual pressure frequently erode the internal auditory meatus (fig. 913). If the substance of the tumour is resistant and cannot be removed by suction, the capsule may have to be incised and its

contents enucleated by means of the electro-surgical loop. Any attempt to avulse the eighth nerve together with the tumour may prove fatal, owing to the uncontrollable hæmorrhage from the auditory and other arteries, or damage to the brain stem.

In closing the operation field after a cerebellar operation, the dura mater should not be sutured. The muscles are brought together by means of interrupted sutures and the scalp approximated in the usual way. No drainage is required.

Pineal Tumours. These tumours are more common than is generally supposed. Owing to their proximity to the superior corpora quadrigemina, they often give rise to a definite pineal syndrome. The pineal

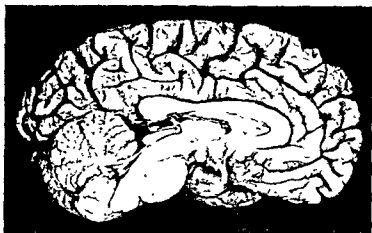


Fig. 914.—MESIAL SECTION OF A BRAIN SHOWING A LARGE PINEAL CYST LYING BETWEEN THE SPLENIUM OF THE CORPUS CALLOSUM AND THE CORPORA QUADRIGEMINA.

body has a definite tendency to calcify, and pineal tumours are often radio-opaque. Cysts are also liable to develop in the pineal (fig. 914), and to give rise to pressure symptoms. Surgical extirpation must be regarded as the only rational form of treatment for pineal tumours. Operative treatment may be followed by a course of deep X-ray therapy, as it is often impossible to be quite certain that every particle of the tumour has been removed.

There are two methods of approach to pineal tumours, and both demand a large right occipito-parietal osteoplastic flap. Dandy's approach is the operation of choice. The dura mater is opened widely as a flap and turned downwards. Some superficial cerebral veins running into the longitudinal sinus must be secured between fine ligatures or silver clips. Care should be taken to avoid injury to the vein which drains the Rolandic area of the brain, otherwise a transient

hemiplegia may result. After the cerebral veins have been divided, the whole of the posterior extremity of the hemisphere¹ is retracted to such an extent as to expose the falx cerebri. Continued retraction will bring the inferior longitudinal sinus into view, and beneath it the corpus callosum. In order to obtain adequate retraction without damaging the cortex of the hemisphere, it is always necessary to tap the lateral ventricle. To obtain an adequate exposure of the splenium of the corpus callosum, it is often advisable to divide the inferior longitudinal sinus between silver clips and then slit up the lower border

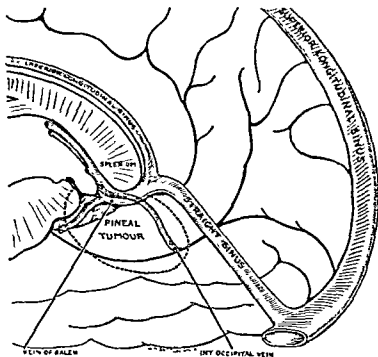


Fig. 915.—DIAGRAM SHOWING THE POSITION OF A PINEAL TUMOUR AND ITS RELATIONS TO THE VENOUS SINUSES AND VEINS.

of the falx for half an inch or more. The splenium of the corpus callosum is then incised in the mid-line and the tumour exposed. The most important structure in relation to the tumour is the great vein of Galen which lies under the fornix. This vein and its tributaries should be carefully preserved (fig. 915). The tumour must be carefully dissected out. In this procedure the third ventricle is sometimes opened. All bleeding is controlled by the application of silver clips or the use of the diathermy point. The posterior part of the cerebral

¹ This is generally feasible owing to the fact that pineal tumours are usually associated with hydrocephalus, which can be tapped, thus reducing the bulk of the hemisphere.

hemisphere is allowed to fall back into place, and the dura mater sutured with one or two tethering sutures. Drainage for a day or so is often necessary. The osteoplastic flap is replaced and the scalp sutured.

The second method of surgical removal of a pineal tumour is that devised by Van Wagenen, in which the tumour is attacked through the dilated lateral ventricle. This is an easier method because as soon as the ventricle is opened the tumour can be seen bulging through the median wall of the ventricle. The disadvantage of this method is that it usually leaves some permanent disturbance of function in the form of hemiplegia and homonymous hemianopia.

It is a remarkable fact that an internal hydrocephalus, although causing gradual destruction of cerebral tissue, is an advantage to the surgeon when removing a pineal tumour. It would otherwise be impossible to retract the posterior part of a normal hemisphere sufficiently without causing some permanent damage. When the fluid from the ventricle is withdrawn in a case of internal hydrocephalus, the flattened-out hemisphere can be retracted without any further damage ensuing. Post-operative radiation therapy is necessary in most cases after the removal of pineal tumours, as it is impossible to be absolutely certain that every particle of the tumour has been removed.

Angiomata. These are uncommon tumours and occur in two forms. In one, an angiomatous nodule may be found deeply embedded in the brain substance and surrounded by a cyst. These cases are suitable for treatment with the diathermy point. The other type occurs as a mass of dilated thin-walled vessels which are quite unsuitable for excision owing to the uncontrollable hæmorrhage which would inevitably ensue. Some of the larger vessels may be occluded with silver clips, but the best form of treatment is to give deep X-ray therapy. Quite good results have been achieved by this method.

Post-operative Treatment of Brain Operations. One of the best methods of combating definite shock from which a patient may suffer after a brain operation is to give five or six ounces of black coffee per rectum. If there has been much loss of blood and the blood-pressure is low, a blood-transfusion should be given.

As a rule, pain in the wound is very slight, and if present can be controlled by small doses of morphia. Uncontrollable pain persisting after twenty-four hours is very suggestive of internal hæmorrhage.

If, in addition to pain, the patient becomes restless and respiration slow, it is absolutely necessary to open the wound, elevate the bone flap, suck out the blood clot, and secure the bleeding points.

Vomiting is not a common sequel to brain operations, but it occurs occasionally after cerebellar operations and may be due to irritation of the floor of the fourth ventricle.

Headache may occur after any operation on the brain, and is quite commonly caused by slight hæmorrhage, which is often relieved by lumbar puncture. This may have to be repeated several times.

Mania is sometimes a post-operative complication in those cases where a large tumour has been removed from the frontal lobe. Strong sedatives are required to keep the patient from becoming exhausted, or from damaging the wound.

Hyperpyrexia is the most troublesome complication which occurs as a post-operative sequel; fortunately it is not common. It demands immediate treatment, otherwise the patient will die. The temperature, which often rises to 106° , must be lowered, and this can be effected by removing all bed and clothing from the patient, wrapping him up in a wet blanket, and maintaining this treatment until the temperature falls to 99° or 100° .

The patient should always be encouraged to drink plenty of fluid in order to replace the loss of blood and of cerebro-spinal fluid.

Post-operative Radiation Treatment. It is a curious fact that the majority of cerebral tumours are radio-sensitive, and that the most rapidly growing tumours are the most sensitive. As the surgical removal of tumours of the brain is in the majority of cases incomplete, it is necessary to complete the cure by radio-therapy. Both X-rays and the gamma rays of radium are equally effective.

It is necessary that a decompression should be performed prior to any radiation therapy, as some œdema of the brain always follows this form of treatment. Two weeks after the decompression and when the scalp wound has healed, the head is covered with a cap of Columbia paste and the opening in the skull is marked on the cap. Screened radium needles containing 1 and 1.5 milligrammes are used. The cap is worn continuously for fifteen to eighteen hours each day. An average total dose should be 16,000 mgm. hours. There is less reaction after radium than after X-ray treatment.

ABSCESS OF THE BRAIN

Pyogenic infection is, of course, the ultimate cause of all cerebral suppuration, but the manner in which the organisms find their way to the brain varies considerably.

A cerebral abscess may be due to traumatism, either in the early or late stages of head injury. However, the commonest cause of all abscesses in the brain is chronic otorrhœa (fig. 916), the cerebellum being almost as frequently involved as the cerebrum. In the former, the abscess is usually in the anterior portion of the lateral lobe (n fig. 916) close to the back of the petrous bone, whilst in the latter the posterior portion of the temporo-sphenoidal lobe is most frequently affected. The inflammation may spread directly from the tympanic cavity or inner aspect of the mastoid process through the bone to the membranes which become adherent to the brain, and subsequently involve the cerebral substance. Occasionally, a subcranial abscess is first developed (B fig. 916), and the cerebral affection follows. In some cases a perforation through the tegmen tympani communicates with an abscess cavity, and the abscess discharges and drains through the ear. More commonly, a layer of brain tissue intervenes between the membranes and the pus, and infection then spreads along the cerebral vessels and their sheaths.

Abscesses of a similar type, occupying the anterior part of the frontal lobe, occur in connection with suppuration in the frontal sinus, the abscess being usually acute and secondary to a frontal osteomyelitis. An abscess may also follow purulent infection of the sphenoidal and ethmoidal sinuses, or thrombosis of the cavernous sinus.

The treatment of a brain abscess follows the usual rule, viz., to give an exit to the pus as soon as possible; no delay is justifiable once the diagnosis has been made. The patient is prepared in the same way as

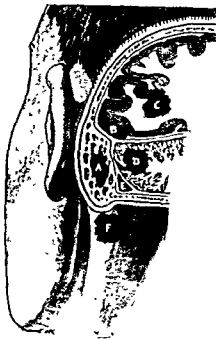


Fig. 916.—DIAGRAM TO REPRESENT THE COURSE OF INFLAMMATORY TROUBLE FROM SUPPURATIVE DISEASE OF THE MIDDLE EAR.

- A. Dilated and infected mastoid antrum.
- B. Subcranial (extra-dural) abscess from infection through the roof of the middle ear or mastoid.
- C. Abscess in temporo-sphenoidal lobe.
- D. Cerebellar abscess.
- E. Lateral sinus.
- F. Berrold's abscess through a perforation in the tip of the mastoid process.

for operation on a cerebral tumour. A flap of scalp tissue is raised, and in such a manner as will serve most effectively for subsequent drainage. A gouge or burr is applied in accordance with the special indications given by the symptoms of the case. When the circle of bone has been removed, the exposed surface and cut edge should be well rubbed over with powdered iodoform and boric acid, or with B.I.P.P., in order to guard them from infection. The dura mater, which bulges into the wound but does not pulsate, is then carefully incised. A mere slit is all that is required, and by this means the abscess cavity may be opened; more usually, however, the brain substance protrudes. In the latter case, careful exploration of the brain should be made in different directions, with a Cushing pus-seeker. In a temporo-sphenoidal abscess the most likely direction is downwards and inwards, towards the tegmen tympani. Pus, when discovered, is allowed to escape. A fine drainage-tube is inserted and the wound lightly packed with iodoform gauze. The tube should be removed each day and a new one inserted. Drainage should be kept up for at least ten days and the wound then allowed to granulate.

Symptoms of re-accumulation or of extension of the mischief to the meninges will, of course, necessitate a re-opening of the wound, and the institution of free and effective drainage. It is important to make a small opening through the dura mater, as otherwise a cerebral hernia is sure to ensue.

In middle ear disease, diagnosis regarding the presence of an abscess and its situation is often doubtful. If suspected, the antrum and attic should be opened and explored thoroughly. If the disease is more marked in the former, the further steps of the operation must be directed towards the cerebellum, but if in the latter, towards the cerebrum. By carefully removing the bone behind and above the antrum, the lateral sinus is exposed, and by working above and below it the cerebrum or cerebellum can be examined and, if need be, incised.

CHAPTER IV

TRIGEMINAL NEURALGIA

NEURALGIA of the fifth cranial nerve, or *tic douloureux*, is a condition which is characterised by severe paroxysmal attacks of acute pain along one or more divisions of the nerve without there being any evidence whatsoever of any organic disease of the nerve itself. The ætiology of the condition is still unknown ; it is rare before middle life and is more common in females. If medical means, including the inhalation of trichlorethylene, fail to cure the condition then surgical measures must be adopted, as the pain is so severe that patients may even become suicidal in their attempts to get relief. The surgical measures which may be adopted are alcoholic injections into the nerve trunks or into the Gasserian ganglion itself, and if this fails then division of the sensory root should be performed. All operations on the ganglion itself have been abandoned as they do not give such good results as section of the sensory root.

As the disorder frequently affects the second and third divisions of the nerve, while the first is but rarely involved, any alcohol injections to give relief of pain should be given into the main divisions as they emerge from the foramina in the skull. Injections into the infra-orbital nerve or the mental nerve are not likely to give relief, as reference to figure 917 will readily confirm.

There can be no dogmatic advice with regard to patients suffering from trigeminal neuralgia, as to which form of treatment is the best ; every patient must be considered independently. If the patient is in good health apart from the neuralgia, then open operation and division of the sensory root is undoubtedly the treatment. If, on the other hand, the patient is aged and debilitated, alcohol injection is the obvious treatment.

Even in those cases where open division of the sensory root is contemplated, it is a sound procedure to inject the Gasserian ganglion

prior to the operation, so that the patient may experience the numbness of the face which is permanent after the division of the sensory root, but temporary after alcohol injections. This is quite necessary, as

frequently patients when cured of their neuralgia complain bitterly of the numbness or "deadness" of the face, and even go so far as to blame the surgeon for not telling them before the operation that such a condition would ensue.

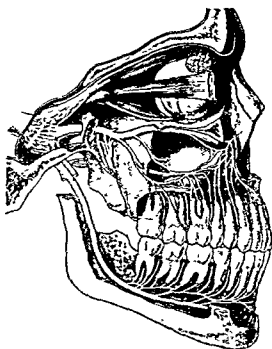


Fig. 917.—DIAGRAM SHOWING THE MAIN TRUNKS OF THE TRIGEMINAL NERVE. THE POSITION OF THE GASSERIAN GANGLION CAN BE EASILY SEEN.

Alcohol injections. There is only one way in which the technique of alcohol injections into the second and third divisions of the fifth nerve or into the Gasserian ganglion itself can be perfected, and that is by repeated attempts on the cadaver. Not until the surgeon is quite familiar with the method on the cadaver should he attempt the injection

on the living patient. In the past, failure of injections to cure the pain has quite often been due to the fact that they have been carried out by inexperienced individuals.

The equipment required consists of a 2 cc. Record syringe and a set of needles as shown in figure 918. There are many varieties of

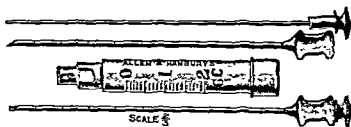


Fig. 918.—SYRINGE AND NEEDLES USED FOR ALCOHOL INJECTIONS.

needles, but they should be made of stainless steel and vary from 3 to 5 inches in length, and should be graduated in centimetres. Some 1 per cent solution of novocaine and some 90 per cent alcohol complete

the requirements. Although some authorities advise a general anæsthetic for the injections, this should always be avoided, as it is very important to have the co-operation of the patient.

Injection of the Maxillary Nerve. There is only one real method for injecting this nerve, which should always be done at the foramen rotundum, and that is the one devised by Dr. Harris of St. Mary's Hospital.

The patient is seated on a chair, while the head is kept still by a nurse who holds it from behind. The skin of the face is painted with some 2½ per cent solution of iodine in absolute alcohol. Two points on the skin of the cheek require to be marked out, the first being the point where the anterior border of the coronoid process forms an angle with the malar bone. The second point is the frontal process of the malar bone where it bends sharply upwards. These two points are joined by a straight line.

Some 1 per cent novocaine is injected with a hypodermic needle into the lower of the two points marked out. The injecting needle is now taken in the right hand with the index finger pressed against the barrel of the needle to steady it. The needle is gently pressed through the cheek in an inward and upward direction at an angle of about forty degrees above the horizontal, taking care to keep the line of the needle in the direction of the line drawn on the surface of the cheek. The point of the needle will pass behind the maxilla and enter the pterygo-maxillary fissure. The superior maxillary nerve is encountered at the foramen rotundum, usually at a depth of 2 inches. The patient complains of pain which is referred to the side of the nose and upper lip wherever the nerve is punctured by the needle. It is a good plan to inject two or three drops of novocaine solution, and after half a minute there should be some slight anæsthesia in the peripheral distribution of the second division of the fifth nerve on the face. If this occurs, then five or six drops of 90 per cent alcohol are slowly injected, producing, to begin with, a burning sensation in the cheek, lip, and nose, followed by anæsthesia.

If the novocaine were not injected previous to the injection of alcohol, the patient would suffer intolerable pain.

Injection of the Mandibular Nerve. There are two routes available for the injection of this nerve, both having their advocates and both giving good results. There is the horizontal lateral approach, which has been perfected by Harris, and an ascending anterior approach, which is

advocated by Hartel. Personally, I have always used the anterior approach for a number of years and it gives excellent results (fig. 919).

Lateral route. In this route the needle passes beneath the zygoma and through the sigmoid notch of the mandible. It is therefore important to mark out the under-surface of the zygoma, which can readily be done as it is subcutaneous. The lower border of the sigmoid notch can be demarcated by a line drawn from the incisura notch of the ear to the lower border of the ala of the nose. The vertical plane,

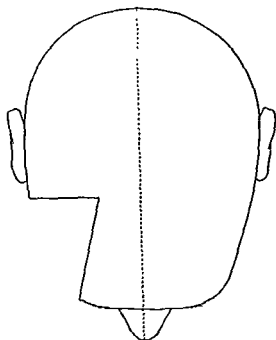


FIG. 919.—DIAGRAM SHOWING THE TWO METHODS OF APPROACH WHEN INJECTING THE THIRD DIVISION OF THE FIFTH NERVE. HARRIS'S METHOD FROM THE SIDE IS THE SHORTER OF THE TWO.

which, passing at right angles to the side of the cheek, cuts the foramen ovale, can be marked out quite easily, as it lies 1 inch in front of the middle of the external auditory meatus. The needle is introduced at the point where the vertical line intersects the line marking the sigmoid notch, and some novocaine is injected. The needle is then pushed inwards and slightly upwards until the foramen ovale is reached, which is usually at a depth of 5 cm. The patient often complains of a stabbing pain in the lower lip and chin; a few drops of novocaine are injected and if anaesthesia develops in the area of

distribution of the nerve, 1 cubic centimetre of 90 per cent alcohol is slowly injected. If the needle is directed too far backwards, its point may enter the Eustachian tube and the patient will complain of pain in the ear, while if the needle is inserted too low, the pharynx may be perforated, causing pain in the throat. In either case it is essential that the needle should be withdrawn and another attempt made to enter the foramen ovale.

As quite a number of patients who suffer from trigeminal neuralgia are edentulous, there may be some difficulty in traversing the sigmoid notch; in these cases, if the mouth is fixed in an open position by means of a dental prop, the difficulty is easily overcome.

Anterior route. This is the longer of the two routes, the foramen ovale lying about 8.5 cm. from the skin (see fig. 919). The foramen is approached from a better angle from below and in front, and is, in my opinion, a more satisfactory method. The patient is seated on a chair facing the surgeon, while a nurse steadies the back of the head. After some iodine solution has been applied to the cheek a point is marked out

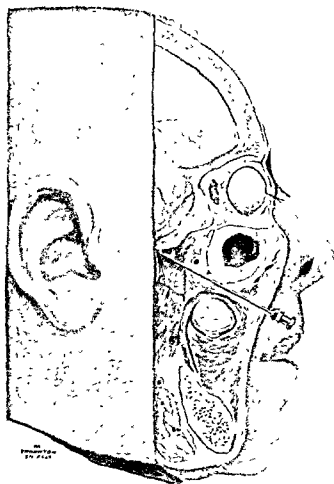


Fig. 920.—PICTURE SHOWING THE POSITION OF THE NEEDLE WHEN INJECTING THE MANDIBULAR NERVE FROM THE FRONT.

(From a dissection in the Anatomical Department of the Middlesex Hospital. By kind permission of Professor Yates.)

2 cm. external to the angle of the mouth; this point is then infiltrated with some novocaine solution. A 5-inch needle is introduced at the point selected and passed in an upward, backward, and inward direction so that it is superficial to the buccinator muscle but deep to the mandible (figs. 920 and 921).

The needle can be guided by a finger introduced into the patient's mouth. It is made to pass through the external pterygoid muscle and into the nerve as it passes out of the foramen ovale. Quite frequently

the nerve is "hit off" at the first attempt, but at other times the point of the needle strikes the smooth infra-temporal crest of the temporal bone. In such cases it is necessary to manipulate carefully backwards so as to enter the foramen ovale. It is quite possible to enter the Eustachian tube or pharynx, when the needle is introduced too horizontally or too medially; in either case the needle must be withdrawn and another attempt made. It is very important not to introduce the



Fig 921.—DISSECTION SHOWING THE POSITION OF THE NEEDLE IN THE FORAMEN OVALE (ANTERIOR APPROACH).

(By kind permission of Professor Yates)

needle too deeply, as it may pass into the Gasserian ganglion and through into the subarachnoid space; in such a case cerebro-spinal fluid will drip from the needle when the stylet is withdrawn. On no account should any alcohol be injected in such a case, or paralysis of the sixth, seventh, and eighth cranial nerves may occur.

On very rare occasions the internal maxillary artery may be injured and a hæmatoma may develop; this, however, calls for no treatment. As soon as the nerve is reached it is injected in a similar manner to

that described in the lateral method of approach. Figure 922, which was kindly drawn by Professor Parsons from a section which he prepared for me at St. Thomas's Hospital, will give the reader a good idea of the relationship of the mandibular nerve to the pterygoid muscles.

Injection of the Gasserian Ganglion. Although the ganglion may be injected by a lateral or an anterior route, the latter is far more reliable and satisfactory and is the only one described here. The method is in every way similar to that used for injecting the mandibular nerve from the front, except that the needle is introduced a further centimetre when the nerve is reached at the foramen ovale. It is very important that no alcohol should reach the sub-arachnoid space.

After injection of the ganglion has produced anæsthesia of all three divisions of the trigeminal nerve, neuropathic keratitis may occur. It is therefore a wise precaution to stitch the upper and lower lids together. The muscles of mastication are frequently paralysed after alcohol injection into the ganglion, but motor recovery is generally the rule after two or three months. In rare cases, where the neuralgia is bilateral, it is important not to inject the second side until the masticatory muscles on the first side have fully recovered their tone, or mastication will be impossible. It is a very wise precaution to X-ray the skull in all cases where injection into the ganglion is contemplated, so as to see the shape, size, and position of the foramen ovale.

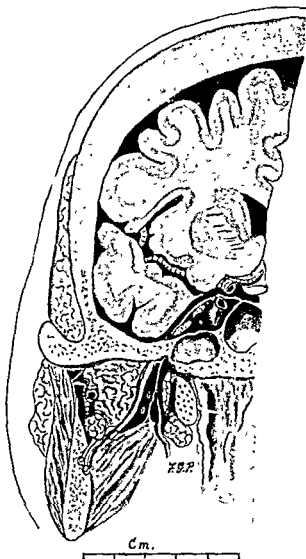


Fig. 922.—DRAWING OF A FROZEN SECTION 2 MM. IN FRONT OF THE FORAMEN OVALE SEEN FROM IN FRONT. THE RELATION OF THE THIRD DIVISION OF THE FIFTH NERVE TO THE PTERYGOID MUSCLES CAN BE READILY SEEN.

(By kind permission of Professor F. O. Parsons, St Thomas's Hospital.)

Division of the Sensory Root. This operation, which is associated with the name of Frazier, has replaced all operations on the Gasserian ganglion, as it gives such excellent results. General anæsthesia combined with local novocaine infiltration into the area of operation is preferred to local anæsthesia by itself. The patient should be operated upon in a dental chair so as to maintain the head in a vertical position; by so doing, venous bleeding is reduced, and escape of fluid from the somewhat small and dependent operation area is greatly facilitated. Some castor oil drops should be instilled into the eye on the affected side, and a piece of gutta-percha tissue should be used to cover it.

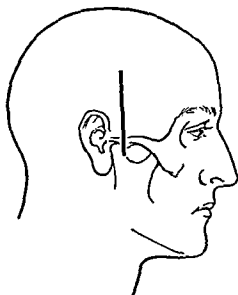


Fig. 923.—THE INCISION IN THE SCALP FOR EXPOSURE OF THE SENSORY ROOT OF THE FIFTH NERVE.

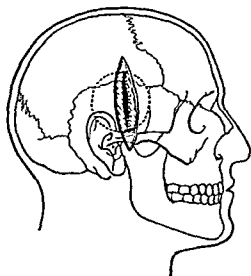


Fig. 924.—DIAGRAM SHOWING THE INCISION THROUGH THE TEMPORAL MUSCLE. THE CIRCULAR DOTTED LINE INDICATES THE OPENING MADE IN THE SKULL.

The scalp in the region of the temporal fossa should be infiltrated with $\frac{1}{2}$ per cent novocaine. An incision, 3 inches in length, is made in front of the ear extending over the zygoma (fig. 923).

The vertical incision has replaced all the old-fashioned horseshoe flaps, as it gives quite adequate exposure. The temporal fascia and underlying muscle are incised in the same line as the skin incision and retracted laterally. The periosteum is incised and detached from the temporal bone by means of a periosteal elevator. A burr hole is then made through the temporal bone; this opening is then enlarged with bone forceps until it is about two inches in diameter (fig. 924).

The opening should extend downwards as far as the infra-temporal crest. The dura mater is carefully separated from the base of the skull

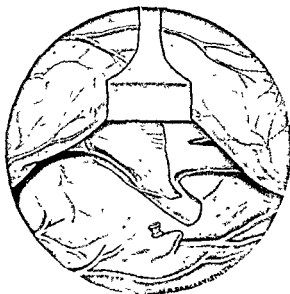


Fig. 925.—DRAWING SHOWING EXPOSURE OF GASSERIAN GANGLION. THE VISCERAL LAYER OF DURA MATER HAS BEEN RAISED. THE LIGATURED MIDDLE MENINGEAL ARTERY CAN BE SEEN AT THE FORAMEN SPINOSUM.

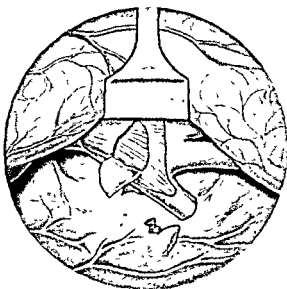


Fig. 926. EXPOSURE OF SENSORY ROOT. A SMALL FLAP OF ARACHNOID HAS BEEN RAISED UP EXPOSING THE FAN SHAPED SENSORY ROOT.

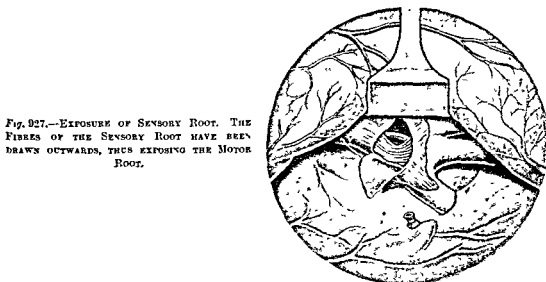


Fig. 927.—EXPOSURE OF SENSORY ROOT. THE FIBRES OF THE SENSORY ROOT HAVE BEEN DRAWN OUTWARDS, THUS EXPOSING THE MOTOR ROOT.

and a blunt retractor is inserted to keep the brain away from the middle fossa. The middle meningeal artery is exposed as it emerges into the middle fossa through the foramen spinosum; it is either tied with two ligatures or coagulated with the diathermy current. In some cases, the foramen spinosum may be plugged with a small spigot of whitewood if other methods fail to stop the bleeding.

The dura mater is still further stripped up until the third division of the fifth nerve and the edge of the foramen ovale are exposed. The sheath of the nerve is incised and gently pushed upwards and backwards, and in so doing the Gasserian ganglion is exposed (fig. 925).

As a general rule, if the area is well illuminated, the sensory root can be seen through the arachnoid sheath. A small flap of arachnoid sheath is now turned downwards, exposing the fan-shaped fibres of the sensory root (fig. 926).

By means of a small blunt hook the fibres of the sensory root are drawn outwards, exposing the motor root, which can generally be recognised without difficulty as it is a small compact structure (fig. 927).

The sensory root is divided just behind the ganglion.

Although some authorities advocate a partial section of the sensory root, leaving the ophthalmic nerve supply intact, this is not to be recommended, as it may lead to saving some fibres of the second division and so not curing the pain. Again, in some cases, after partial section of the sensory root, pain develops in the ophthalmic division.

After the removal of the retractor, the brain falls back into its place and the temporal muscle can be sutured with a few interrupted catgut sutures. The skin is closed with a few interrupted silkworm-gut sutures. A watch-glass is placed over the eye and secured by a piece of strapping. The patient should be kept in bed for a week and may then be discharged. If any signs of keratitis occur, it is advisable to stitch the upper and lower lids together, but this rarely occurs if the patient is instructed not to rub the eye and to keep out of dusty places.

Tumours of the Gasserian Ganglion. These are very rare and give rise to symptoms which simulate those of trigeminal neuralgia, together with early paralysis of the motor root. The pain is incessant and not paroxysmal in character, and this important characteristic should always make the surgeon think of the possibility of a Gasserian ganglion tumour.

These tumours can be exposed and removed through a similar approach to that used in dividing the sensory root of the fifth nerve.

SECTION 2

SPINAL COLUMN

THE SPINAL CORD

THE surgery of the spinal cord has progressed considerably during the last ten years. During that time certain accessory aids to diagnosis have been discovered. The use of *lipiodol*,¹ when injected into the cisterna magna by the method of cisternal puncture, has helped considerably in the diagnosis of intra-dural tumours. The fluid (1 to 1.5 cc.) is slowly injected after cisternal puncture. If there is a spinal block, the lipiodol is held up and the level determined by X-rays (figs. 928 and 929).

Lumbar puncture is more extensively used, and in itself gives useful information, not only regarding the cerebro-spinal fluid pressure, but also regarding the nature of the fluid itself. An examination of the cerebro-spinal fluid below the level of a spinal block due to a tumour will reveal a yellow-coloured fluid (xanthochromine) with a high percentage of albumen and increased globulin.

The technique of lumbar puncture is quite simple. A stout anti-toxin or exploring needle should be selected and sterilised by boiling, and the skin in the region of the third and fourth lumbar interspaces (the spinal process of the fourth vertebra is on a line joining the iliac crests) should be carefully purified. The patient sits or lies with the body well flexed. The needle is then inserted in the fourth interspace, just to one side of the mid-line. The direction of the needle is slightly upwards and forwards. In most cases the needle will go straight into the spinal canal below the termination of the spinal cord, and the cerebro-spinal fluid will escape (fig. 930). If bone is encountered, it is advisable to withdraw the needle and re-insert it at a slightly

¹ Lipiodol is a colloidal solution of iodine in oil of poppy in the proportion of 0.54 cgm. of iodine to 1 cc. of the oil.



FIG. 929.—INTRACRANIAL INTRACRANIAL TUMOR AT THE LEVEL OF THE 10TH THORACIC VERTEBRA, LATERAL VIEW OF THE SPINE AFTER LITHOTOMY, INJECTION.



FIG. 928.—INTRA-MEMBRANOUS TUMOR AT THE LEVEL OF THE 4TH, 5TH AND 6TH CERVICAL VERTEBRAE, X-RAY AFTER THE INTRODUCTION OF 1-2 CC. OF LITHOLUOL.

different angle. In cases of repeated failure, the third interspace may be tried. Under ordinary circumstances the fluid escapes quietly, drop by drop; but in cases of increased tension, it may gush out. The pressure of the fluid can easily be measured by a manometer (fig. 931).

The anæsthetic used in spinal operations must give complete relaxation of the skeletal musculature. As a routine, avertin anæsthesia combined with intra-tracheal gas and oxygen gives excellent

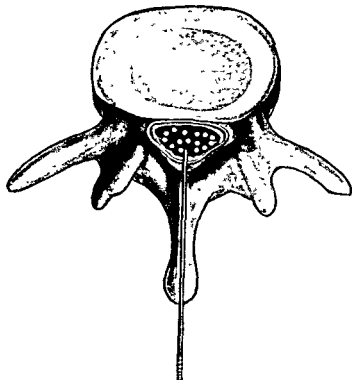


Fig. 930.—DIAGRAM INDICATING THE NEEDLE IN THE THECA IN THE OPERATION OF LUMBAR PUNCTURE.

results. Local infiltration of the skin and spinal muscles with 0·5 per cent of novocaine is always advisable, as it considerably lessens both shock and hæmorrhage.

The position of the patient is important; a prone position with a pillow under the thorax gives the surgeon as much room as he requires and respirations are not embarrassed (fig. 932).

SPINA BIFIDA

Spina bifida is the condition resulting from the failure of closure of the vertebral canal. In most of its varieties this defect is associated

with the visible protrusion of the spinal cord or its membranes, the exception being spina bifida occulta, where this does not occur. In

the course of normal development the spinal cord is formed from a linear depression of the epiblast. Union of the lips of this medullary groove takes place to form the spinal cord with its central canal. The epiblast unites again to cover the primitive spinal cord. Later, the growth inwards of the mesoblast, which is to form the laminae and spinal membranes, separates the two epiblastic structures—skin and spinal cord. The closure of the central canal begins in the thoracic region of the medullary groove, and progresses in both directions, the caudal portion being the last to close. The failure of this development at any of its stages results in one or other of the various types of spina bifida.

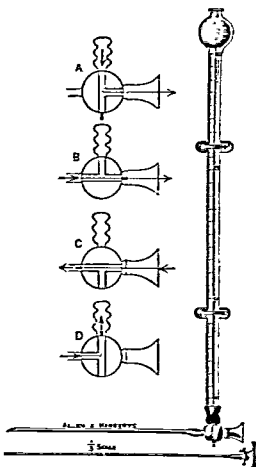


Fig. 331.—GREENFIELD'S CEREBRO-SPINAL MANOMETER FOR MEASURING THE PRESSURE OF THE CEREBRO-SPINAL FLUID. The manometer is attached by rubber tubing to the lumbar puncture needle as soon as it is felt to have entered the spinal column. Then while one hand holds the needle in place, the other simply removes the stylette, and turns the stopcock through a quarter of a circle in the direction of the manometer tube (D). When the pressure and pulsation of the fluid has been noted, a turn of the tap towards the handle of the needle (E) allows the fluid to run out of the manometer into a collecting tube and also allows further flow of fluid from the spinal canal. When the tap is turned away from the manometer (A) the manometer empties itself but the spinal canal is shut off. If it is desired to inject anything into the spinal canal, the tap may be turned towards the point of the needle, so that the manometer is shut off (C).

last to close. The cord appears as a red, raw area (area medullo-vasculosa), surrounded by a zone covered with a thin layer of epithelium (zona epithelio-serosa). The child, if not still-born, does not survive more than a day or two.

Types. (1) *Complete rhachischisis.* This condition follows the failure of union of any part of the lips of the medullary groove. It is very rare and is not compatible with viability.

(2) *Partial rhachischisis or myelocele.* The non-union of the medullary groove is limited in extent and, as a rule, affects that portion which is normally the

(3) *Meningocele*. A herniation of the arachnoid and dura mater has taken place through a deficiency in the posterior walls of the vertebræ, forming a tumour which is covered by skin. The spinal cord is normal in position. Clinically, the condition presents itself as a cystic swelling over the lower part of the back. It is translucent. The skin over a meningocele is usually normal. Pressure over the swelling may diminish its size, and an impulse may be felt on coughing or crying (see fig. 935).

(4) *Meningo-myelocele*. This condition differs from the preceding in that the spinal cord is no longer normal in position, but herniates

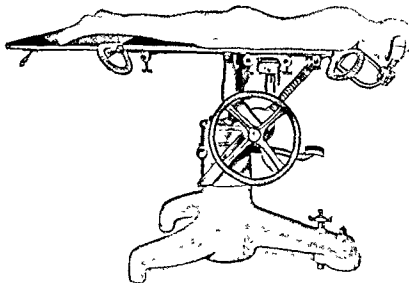


Fig. 932.—POSITION OF PATIENT FOR OPERATIONS ON THE SPINAL CORD.

backwards into the sac of the tumour. Both the spinal cord and the nerve-roots may be adherent to the inner wall of the sac, and can then be seen on trans-illumination (fig. 933). It appears as a flattened tumour, frequently with a centrally situated groove which indicates the attachment of the cord. Clinical evidence of interference with the function of the cord is usually present in the form of paralysis, trophic disturbances, etc. This type of spina bifida occurs most frequently in the lumbar region.

(5) *Syringo-myelocele*. In this type the central canal of the cord is distended, and its thin endymal dorsal wall projects backwards through the deficiency in the posterior arches. The dura mater is completely absent over the dorsal surface of the tumour, and the arachnoid is adherent to the skin. The condition is associated with nervous lesions similar to the previous type. Pressure on the sac of a

spina bifida may cause bulging of the anterior fontanelle (fig. 934). Ulceration of the overlying skin is very liable to occur, and is followed by rupture of the sac and subsequent infection.

The nervous lesions present take the form of paralysis of the lower limbs associated with deformity, paralysis of the sphincters of the bladder and anal canal, and trophic ulcers. Frequently other deformities are present in the child, such as scoliosis, absence of ribs, intestinal



Fig. 933.—SPINA BIFIDA IN THE LUMBO-SACRAL REGION ASSOCIATED WITH CLUB FOOT.



Fig. 934.—LARGE SPINA BIFIDA IN THE LUMBAR REGION.

defects, and hydrocephalus. This latter may follow surgical treatment of the condition. Those with a meningocele are the only ones likely to survive early infancy.

(6) *Spina Bifida Occulta*. This condition undoubtedly occurs in many cases without giving any symptoms of its presence. In others, however, interference with the function of the cord may result from either traction on the latter by a band of adhesion between it and the skin overlying the defect in the vertebra, or from the pressure of an associated tumour, usually a lipoma. As growth takes place and particularly between the ages of ten and fifteen, the cord is pulled upon and results in paralysis of the lower limbs, trophic changes and sphincter disturbances.

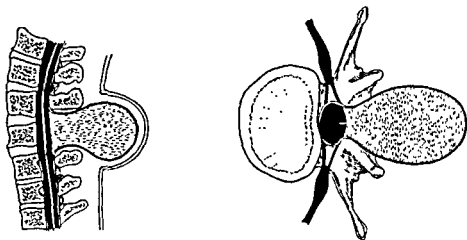


Fig. 935.—HORIZONTAL AND VERTICAL SECTIONS OF A SPINAL MENINGOCELE.

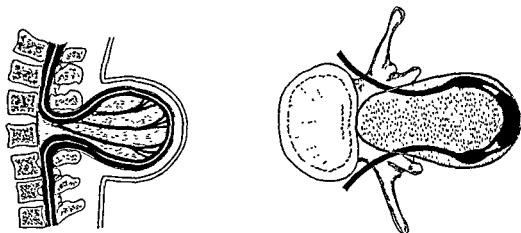


Fig. 936.—DIAGRAM OF A MENINGO-MYELOCELE.

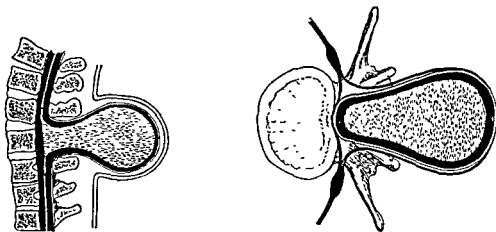


Fig. 937.—DIAGRAM OF A STRINGO-MYELOCELE.

The skin over the defect is frequently excessively hairy, and a tumour, usually a lipoma, may be present (fig. 938).

Many of the cases of spina bifida are still-born, and of those which survive birth a considerable proportion die within the first year.

Treatment. Successful operative treatment can, as a rule, only be undertaken for meningoceles and for those cases of spina bifida occulta giving rise to symptoms. In meningo-myeloceles and syringo-myeloceles, attempts to close the defect should only be made in the exceptional cases in which paralyses, etc., are absent.



Fig. 938.—Scoligram of a case of spina bifida occulta in the lower lumbar region. The defect in the posterior part of the 5th lumbar vertebra can be easily seen.

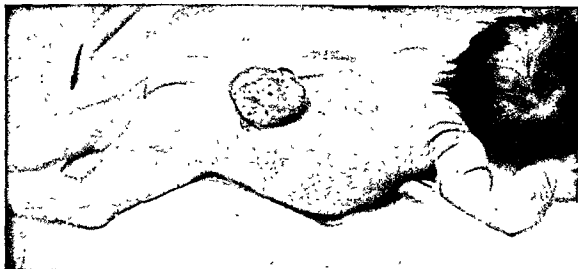


Fig. 939.—MENINGOCELE IN AN INFANT TWO WEEKS OLD JUST PRIOR TO OPERATION.

For *spina bifida occulta*, any tumour present is excised, and by careful dissection the fibrous band connecting the skin and spinal cord is defined and cut across. The spinal muscles are carefully sutured over the defect.

In meningoceles the dural sac is carefully exposed and its neck defined. The sac is then removed and the neck sutured. An attempt is made to suture the muscles over the defect (figs. 939 and 940). There is a risk of the subsequent development of hydrocephalus after the operative treatment of *spina bifida*.



Fig. 940.—SAME PATIENT AS FIG. 939 ONE MONTH AFTER OPERATION.

SPINAL TUMOURS

The term "spinal tumour," as in analogous descriptions of cranial tumour, is used in its broadest sense, and includes not only tumours arising from the cord itself, but also those which have their origin in its protective spinal membranes and vertebræ. Furthermore, the term does not apply only to true neoplasms, but embraces also certain chronic inflammatory conditions and cysts.

It is now fifty years since a spinal tumour was first successfully removed by the late Sir Victor Horsley. During this period much has been added to our knowledge of this condition both by careful study of its clinical manifestations and by the introduction of precise methods to help in its diagnosis and accurate localisation.

Although of considerably less frequent occurrence than the cerebral tumour (1 : 6), the condition is a much more hopeful one from the point of view of treatment and prognosis. The more favourable outlook depends on the fact that, whereas the larger proportion of cerebral tumours are non-encapsulated and therefore irremovable, the converse holds good in the case of spinal tumours. It is, in addition, particularly fortunate that compression may be present for a considerable period of time, even years, and yet recovery without serious permanent disability occurs in most cases after removal of the causative tumour.

Classification. The situation of the tumour forms the most satisfactory basis of classification. Tumours may be :

- (1) Extra-dural.
- (2) Intra-dural :
 - (a) Extra-medullary.
 - (b) Intra-medullary.

(1) *Extra-dural Tumours.* The bulk of these are malignant tumours of bone—secondary carcinoma or primary sarcoma. Very much less commonly (1 : 10), a benign tumour, such as an osteoma, chondroma, angioma or lipoma (rare, except in association with spina bifida) may occur.

Exceptionally, pressure symptoms have been found with multiple myelomatosis and again, very rarely, due to the presence of a hydatid cyst.

It will be obvious that only in few cases with this particular type of cord compression can successful surgical intervention be made.

(2) *Intra-dural Tumours.* (a) *Extra-medullary.* In a series of 330 cases operated upon, Frazier found almost 50 per cent to be of this type. (This series, of course, excludes some of the extra-dural type which, on account of their recognition as malignant neoplasms of bone, whether primary or secondary, were not operated upon.) The large



Fig. 941.—ACTUAL SIZE OF EXTRA-MEDULLARY MENINGIOMA AFTER REMOVAL.

majority of tumours of this type are either benign endotheliomata (meningioma, psammoma), or neurofibromata. In very rare cases the tumour may be an angioma, gumma, or tuberculoma.

(b) *Intra-medullary.* These tumours are of a nature similar to those commonly occurring in the brain, and usually called gliomata or glio-sarcomata. They have the same important feature, namely, their infiltrative character, which prevents their surgical extirpation.

This group constituted 11 per cent of Frazier's cases. To sum up, excluding cases of malignant disease of bone, about 50 per cent of spinal tumours are benign tumours which are suitable for surgical measures to be undertaken for their removal.

Considered as a whole, spinal tumours are found most frequently in the thoracic region of the cord, and the common type of tumour, that is the extra-medullary, is found most usually posteriorly or postero-laterally in connection with the sensory nerve roots.

In some cases the tumour present may be partly intra-dural and partly extra-dural, the two portions being connected by a constricted neck. Non-recognition of a dumb-bell tumour, as it is called, may result in only one part of the tumour being removed at operation and failure to relieve the cord compression.

Age and Sex. Spinal tumours occur with equal frequency in males and females. They may be present at all ages, but are most common between the ages of 20 and 50. Tuberculomata are the most common form found in children under the age of 10.

Cause and Duration. The rate of development of a spinal tumour is as a rule slow, but this, of course, varies with the pathological nature of the tumour. It is a remarkable fact that, although severe pressure on the cord of prolonged duration may have occurred, recovery is the rule after removal of the cause, showing that the degenerative changes in the cord itself do not occur with any degree of frequency.

Clinical Features. The presence of a spinal tumour demonstrates itself by the interference which it causes with the function of the spinal cord and its nerve-roots. As in compressive lesions affecting the brain, irritative phenomena precede the development of paralytic ones, pain usually being the earliest symptom.

It is convenient to divide the symptomatology into three stages :

(1) Stage of root involvement. This stage is usually one of long duration, and the symptoms caused are firstly those due to irritation of the nerve-roots, namely, pain areas of hyperæsthesia or paræsthesia, followed later by diminished sensibility and eventually anæsthesia. To begin with, the symptoms are generally unilateral, but later both sides of the body are affected. As might be expected from the usual situation of the tumour, namely, posterior or postero-lateral, disorders of sensation alone may result, and only very much less commonly is there any evidence of affection of the ventrally situated motor roots.

(2) Stage of Brown-Séquard syndrome. This stage is usually of short duration, and is typically present in the case of extra-medullary tumours. When fully established it comprises muscular paralysis and loss of kinæsthetic sense on the same side as the lesion, with loss of pain and temperature sense on the opposite side to the lesion.

(3) Stage of paralysis of the sphincters of the bladder and rectum, and of bilateral motor and sensory paralysis below the level of the lesion, at first partial, but later complete. Trophic disturbances develop. In the case of intra-medullary tumours the first and second stages are usually absent and the early development of the third stage is characteristic. Owing to the infiltrative nature of these tumours the upper limit of the affected parts tends to ascend.

Diagnosis. In recent years considerable help has been obtained in both the diagnosis and localisation of a spinal tumour by methods which are accessory to a general consideration of the patient's history and physical signs. It must be borne in mind, however, that these methods in no way replace the latter. With regard to the localisation

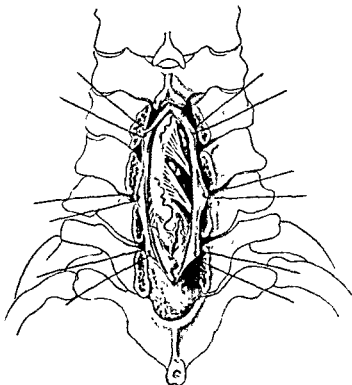


Fig. 942.—EXPOSURE OF EXTRA-MEDULLARY TUMOUR IN THE CERVICAL REGION. THE TUMOUR AFTER REMOVAL CAN BE SEEN IN FIG. 941.

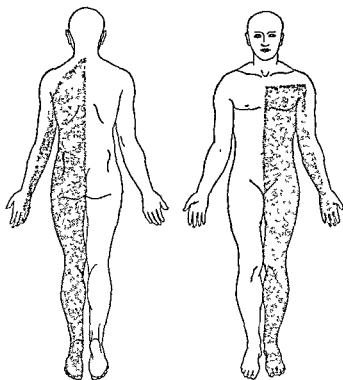


Fig. 943.—DIAGRAMS SHOWING THE AREAS OF LOSS OF PERCEPTION OF HEAT AND PAIN CAUSED BY THE TUMOUR IN FIG. 942.

on clinical grounds alone, it is found that the upper level of sensory impairment provides the most important evidence. Vertebral disease should be excluded by X-ray examination. Evidence of syphilitic lesions elsewhere in the body should be looked for, and the result of a Wassermann reaction obtained in order to exclude this disease.

Of other affections of the spinal cord, disseminated sclerosis, transverse myelitis, and syringo-myelia should be considered.

Lumbar Puncture. Froin, in 1903, described the characteristic syndrome which bears his name, and which consists of xanthochromia and massive coagulation of the lumbar cerebro-spinal fluid below the level of a spinal tumour. There is also an increase in the number of

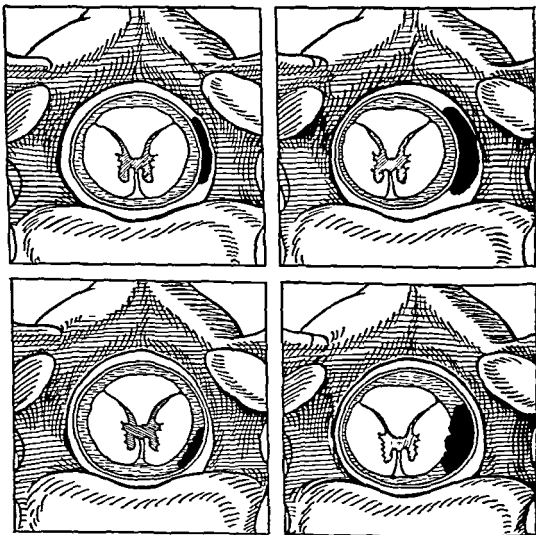


Fig. 944.—THE TWO UPPER DRAWINGS DEPICT HOW AN EXTRA-DURAL TUMOUR COMPRESSES THE CORD, WHILE THE LOWER ONES SHOW THE COMPRESSION CAUSED BY AN INTRA-DURAL TUMOUR.

cells present. Even a very slight increase in the protein content is significant.

The pressure of the fluid below the level of a tumour is very variable and may be either raised or lowered. Queckenstedt, in 1916, described an important test for the presence of a block to the flow of cerebro-spinal fluid in the subarachnoid space. If, during the performance of lumbar puncture, the jugular veins in the neck are compressed the cerebro-spinal fluid pressure rises in a normal subject. In the presence of a spinal tumour which is obstructing the passage of cerebro-spinal fluid, jugular compression fails to produce this effect. It must be remembered, however, that in cases of partial obstruction by a tumour, the test will fail. It is strongly recommended that Queckenstedt's test should be performed after as well as before operation, in order that a successful establishment of a free passage in the subarachnoid space may be confirmed.

Sometimes lumbar puncture aggravates the signs and symptoms, and examination after it may localise the tumour at a higher level in these cases.

Cisterna Puncture. By this means the amount of protein in the fluid obtained can be compared with the amount in the lumbar fluid. In the presence of a spinal tumour there is an increase in the protein content below its level. The pressure of the lumbar and cisterna fluid is normally equal and also rises equally as a result of jugular compression. When a tumour is present the cisternal pressure will be found to be higher than the lumbar, and this difference will increase after jugular compression.

Lipiodol. This substance, introduced by Sicard, is a radio-opaque oil containing iodine. It is prepared in two forms, a heavy and a light oil, of which the former is the one of more value.

Two cubic centimetres of the heavy oil are injected into the cisterna magna. In normal subjects the oil gravitates to the level of the second sacral vertebra, but when a subarachnoid block is present, the oil will be held up at the level of the upper limit of the obstruction, and can be seen if a skiagram be taken. By the combined use of the heavy oil by cisternal puncture, and the light by lumbar puncture, the upper and lower limits of the tumour may be shown.

The oil, after injection, is not absorbed, and it is very possible that its continued presence in the theca may, in time, set up chronic inflammatory reactions in the meninges of the cord. The injection may also

be the cause of the occasional onset of root pains. For these reasons this method is used chiefly for the localisation of tumours rather than for their initial diagnosis.

Treatment. A considerable proportion of spinal tumours are amenable to surgical extirpation. Patients suffering from malignant disease of the vertebræ, primary or secondary, are for the most part not suitable for operation. In a few rare cases, the possibility of the compression being caused by a gumma would indicate intensive anti-syphilitic treatment before operative intervention was indicated.

The spinal cord is exposed by laminectomy. It is essential that the tumour should have been carefully localised before this is undertaken, and in particular the correspondence of the upper level of root involvement to the laminæ to be removed determined. The tendency is for the exposure of the spinal cord to be made too low. Almost the lowest lamina to be removed should be at the level of the highest root involved.

A minimum of three laminæ should be removed and the search for the tumour initiated by careful examination for an extra-dural cause of compression. Before the dura mater is incised hæmostasis should be obtained and gentle palpation made for the tumour. An absence of pulsation of the cord at the site of or below a tumour, and sometimes an area of congestion of the cord and a collection of cerebro-spinal fluid above the tumour, may be of help to the surgeon in revealing its situation.

The commonest situation for the tumour is posterior or posterolateral, but if none is found the cord must be rotated by traction on a ligamentum denticulatum (figs. 945, 946 and 947). Posterior nerve-roots may require section in order to expose and remove the tumour. If a tumour is not found in the area of cord exposed, the use of a probe will not as a rule reveal its situation, and direct exposure by the removal of more laminæ should be made. The existence of dumb-bell tumours should be remembered, and the removal of one portion only of such a tumour avoided.

Intra-medullary tumours are generally irremovable. When dealing with this type of tumour a two-stage operation should be performed. In the first stage a longitudinal incision is made into the spinal cord immediately over the tumour. In the second stage, a fortnight later, partial extension of the tumour may have taken place, and it may now be removable.

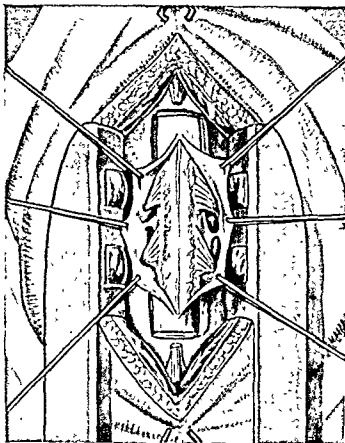


Fig. 943.—OPERATION DRAWING SHOWING AN EXTRA-MEDULLARY TUMOUR SITUATED ON THE POSTERO-LATERAL SURFACE OF THE CORD.

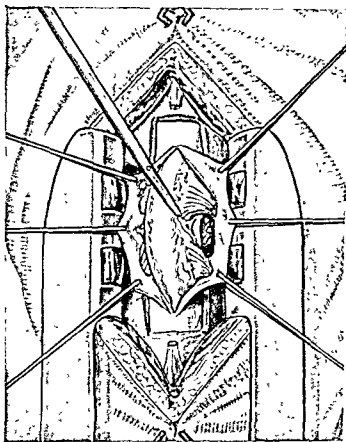


Fig. 946.—DIVISION OF LIGAMENTUM DENTICULATUM AND TRACTION ON SAME GIVES A BETTER EXPOSURE OF THE TUMOUR.

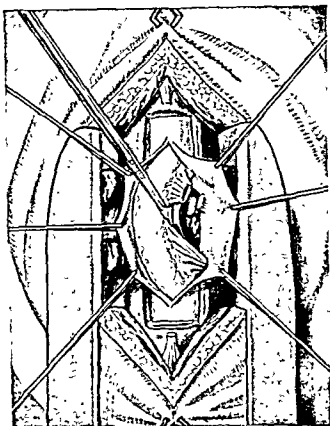


Fig. 947.—THE TUMOUR CANNOT BE ADEQUATELY EXPOSED UNTIL AFTER DIVISION OF ONE OF THE POSTERIOR NERVE-ROOTS IN ADDITION TO THAT OF THE LIGAMENTUM DENTICULATUM.

With this exception, and very occasionally in the case of patients whose general condition demands it, the operation is performed in one stage followed by a course of deep X-ray therapy.

Prognosis. The results of operation are very encouraging. In some cases the recovery of function has been almost immediate, and even in those in whom the spinal cord has been subjected to the most severe degree of compression, the degree of ultimate recovery is extraordinary. The prognosis with the less common intra-medullary tumours is poor.

TUMOURS OF THE CAUDA EQUINA

Compression of the cauda equina is generally due to a tumour, and the commonest tumour is a meningioma (endothelioma). The clinical picture may vary according to the site and extent of the compression. Pain is the earliest and most constant symptom, and it is frequently diagnosed as sciatica. The pain is of a dull aching character, and is

often accompanied by slight twitchings of the muscles of one or both legs. These tumours are often attached to one of the nerve-roots or the membranes surrounding them (figs. 948 and 949).

If the tumour is a large one there may be atrophic paralysis of the muscles below the knee. It is in these cases of doubtful tumours of the cauda equina, that the injection of lipiodol may be of the greatest use to the neurological surgeon.

Cauda equina tumours can usually be removed entirely, and the prognosis is excellent.

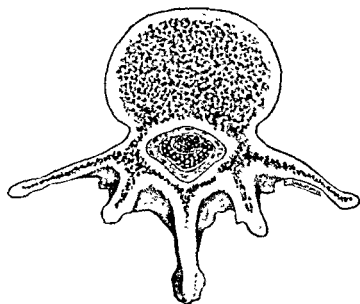


Fig. 948.—DIAGRAM OF A CROSS SECTION OF A LUMBAR VERTEBRA SHOWING THE POSITION OF A CAUDA EQUINA TUMOUR.

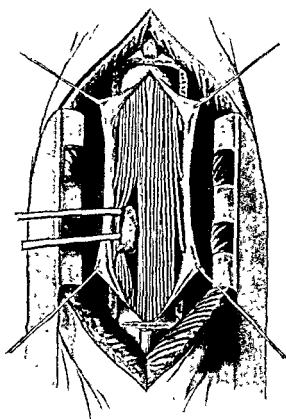


Fig. 949.—DRAWING MADE AT THE TIME OF OPERATION SHOWING A MENINGIOMA OF THE CAUDA EQUINA.

LAMINECTOMY

The operative removal of vertebral laminae may be required for various conditions which fall into one of the following four groups:

- (1) Injuries.
- (2) Tumours.
- (3) For the relief of intractable pain.
- (4) Inflammatory condition :
 - (a) Pott's disease in which immobilisation has failed to relieve compression.

- (b) Acute osteomyelitis of the laminae.
- (c) Meningitis serosa circumscripta.

The main indication for the operation is undoubtedly for the relief of compression, whether resulting from injury, tumour, or the above-mentioned inflammatory processes. For the relief of pain, the object of the operation is to permit section of the appropriate sensory tracts in the spinal cord. This may be accomplished by Spiller's operation of antero-lateral tract chordotomy, or by section of the sensory fibres as they cross to the opposite side of the cord by median chordotomy. The special steps of these two forms of chordotomy will be considered later on page 1861.

As clinical investigations determine an upper limit of compression in terms of spinal segments, the relationship of these to the laminae must be considered before laminectomy is performed. The spinal cord in an adult ends at the level of the lower border of the first lumbar vertebra, so that it follows that the spinal segments must be at a higher level than the corresponding vertebra. As a rough guide, in the cervical region the numerical difference between spinous processes and spinal segments is one, in the upper thoracic region, two, and in the lower thoracic region, three. The five lumbar segments lie opposite the 9th, 10th, and 11th spinous processes, and the five sacral segments opposite the 12th thoracic and first lumbar spines. Localisation with regard to the vertebrae, however, is shown directly in those cases in which a block to the passage of lipiodol has been demonstrated by radiography. Enumeration of the spinous processes is made from the 7th cervical or vertebra prominens and checked by counting from the spine of the 4th lumbar vertebra which lies on a level with the line going to the highest points of the iliac crests.

Anæsthesia. The operation can be performed under either local or general anæsthesia. The latter is distinctly preferable, particularly in the form of intra-tracheal nitrous oxide and oxygen. A combination of this method with local infiltration of the subcutaneous tissue and muscles with $\frac{1}{2}$ per cent novocaine is not uncommonly used.

Position of Patient. The patient lies prone on the operating table, with the site for laminectomy made as prominent as possible either by using sand-bags or by appropriate adjustment of the table.

Operation. A mid-line longitudinal incision some six to eight inches in length, is made down to the deep fascia overlying the tips of the

spinous processes. The centre of the incision lies over the situation of the lesion. The use of a curved incision on one side of the mid-line and the raising up of a flap is only required in cases of severe kyphosis. An incision is now made through the fascia on each side of the spinous processes. The separation of the muscular mass on each side is conveniently performed by means of a broad osteotome or, alternatively, a sharp periosteal elevator, keeping as close to the sides of the spinous

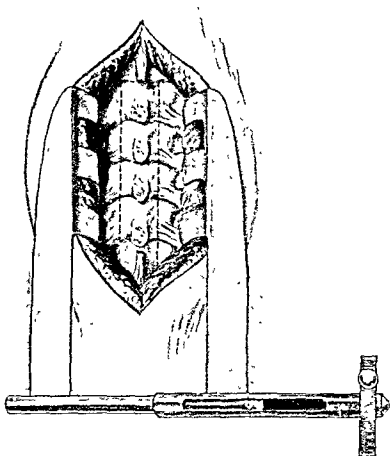


Fig. 950.—LAMINECTOMY. THE SPINOUS PROCESSES HAVE BEEN REMOVED.
THE SPINAL MUSCLES ARE HELD BACK BY MEANS OF A RETRACTOR.

processes as possible. The more the separation of the muscles is made with the periosteum, the less will be the amount of bleeding. The larger bleeding vessels are ligatured. When the muscles have been separated on one side a large swab wrung out in hot saline is pressed firmly into position, whilst a similar separation is proceeded with on the other side. At the lower end of the wound an incision is made between two adjacent spinous processes, and with bone forceps the spinous processes and their connecting ligaments are removed in one piece.

An automatic laminectomy retractor is now placed in position (fig. 950).

Removal of the Laminae. The ease with which this step of the operation is performed varies considerably with the part of the spine concerned. It is most difficult in the lumbar region and easiest in the cervical, the two factors concerned being the degree of development of the paravertebral muscles and the actual thickness of the laminae.

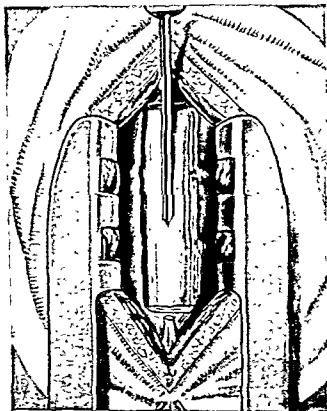


Fig 951.—LAMINECTOMY. METHOD OF OPENING THE DURA MATER.

Difficulty may be experienced in commencing the removal of the laminae, and a convenient plan is to make the initial opening into the spinal canal by means of a $\frac{1}{4}$ -inch trephine. Horsley's forceps, or better still, double-action laminectomy forceps can now be introduced and the laminae removed from below upwards. Both from the point of view of good exposure and of the safety of the underlying cord, the laminae should be divided as near to their junctions with the pedicles as possible. At least three laminae will require removal, and still more can be taken away without prejudice to the subsequent stability of the spine. Before the dura mater is incised, hæmostasis should be secured.

After incision of the dura mater, sling sutures are inserted into each edge for purposes of retraction (fig. 952). The technique of the operation at this stage varies with the condition for which the laminectomy has been performed.

Injuries. Loose fragments of bone or foreign bodies, e.g. a bullet, are removed. For fracture-dislocation, manipulation of the spine to

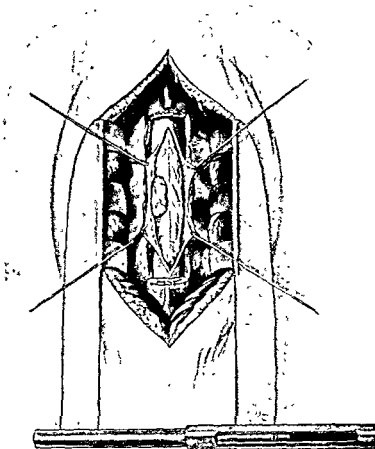


Fig. 952.—LAMINECTOMY. METHOD OF RETRACTING THE DURA MATER BY MEANS OF SLING SUTURES.

produce a reduction of any displacement may be attempted, but it is unlikely that this procedure will be followed by any improvement in the patient's condition. Any prominent sharp edge of bone projecting into the spinal canal should be removed with bone forceps.

Tumours. (See Spinal Tumours on page 1848.)

The Relief of Intractable Pain.

- (1) Section of the antero-lateral tracts.
- (2) Median chordotomy.

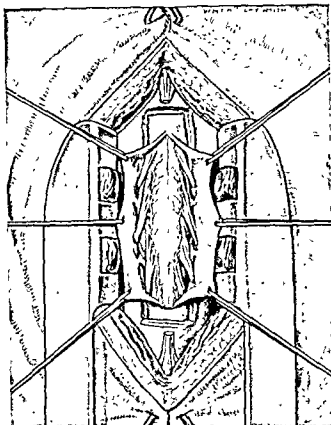


Fig. 953.—EXPOSURE OF INTRA MEDULLARY TUMOUR BY LAMINECTOMY.

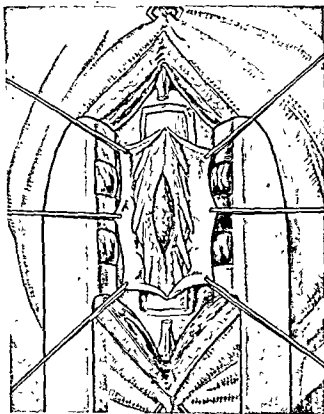


Fig. 954.—INTRA MEDULLARY TUMOUR. A MEDIAN INCISION IS MADE AND THE TUMOUR MAY ATTEMPT TO EXTRUDE ITSELF.

These operations are indicated for :

- (1) Intractable pain—usually as a result of malignant disease.
- (2) Gastric crises.

The site of the section is taken well above the part of the cord where the affected sensory nerves reach the cord. The 4th or 5th thoracic segments are usually chosen. After exposure of the cord it is rotated

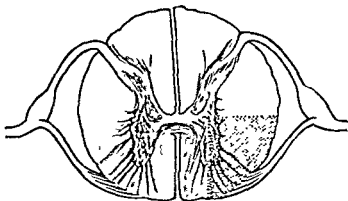


Fig. 955.—DIAGRAM SHOWING THE AMOUNT OF TISSUE DIVIDED IN LATERAL CHORDOTOMY.

by traction on a ligamentum denticulatum, the dural attachment of which has been divided. In this way the lateral aspect of the cord is exposed. The guarded blade of a fine knife is now introduced into the cord at a point immediately anterior to the attachment of the ligamentum denticulatum. The blade is passed transversely to a depth of 3 mm. into the cord and is then brought out by cutting through the cord in a forward direction. The knife leaves the cord about 1 mm.

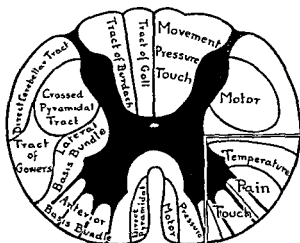


Fig. 956.—DIAGRAM OF A CROSS-SECTION OF THE SPINAL CORD SHOWING THE AMOUNT OF TISSUE INCISED IN THE OPERATION OF LATERAL CHORDOTOMY.

from the mid-line. The antero-lateral column divided is, of course, on the opposite side to that from which the painful stimuli are arising (figs. 955 and 956).

(2) *Median Chordotomy.* In this operation the pain fibres are incised as they cross from one side of the cord to the other. To be successful, accurate knowledge of the situation in which the affected fibres cross is essential. The operation has technical drawbacks in that there is :

- (a) Difficulty in keeping to the mid-line in making the incision in the cord.
- (b) Some risk of damage to the anterior spinal artery.

For these reasons antero-lateral tract section (Spiller's operation) is preferable.

Inflammatory Conditions. Laminectomy in cases of Pott's disease with paraplegia has very few indications, and should only be considered in the very few cases unrelieved by absolute rest in a recumbent position. Acute osteomyelitis of the spine, which is of rare occurrence, necessitates laminectomy. Meningitis serosa circumscripta will, as a rule, be diagnosed as spinal tumour because of the encysted collection of cerebro-spinal fluid resulting in pressure symptoms. Relief of symptoms can, as a rule, only be brought about by releasing fluid by incision.

Syringo-myelia. In a few cases exposure of the spinal cord and incision into the cystic spaces around the central canal has caused some benefit to the patient.

Closure. The dura mater is partly closed by tying together the sling sutures, but no attempt is made to suture the incision completely. Great care must, however, be taken in the suture of the muscles to avoid leakage of the cerebro-spinal fluid afterwards. The muscle masses are approximated in three layers, the two deeper with interrupted catgut and the aponeurosis with a continuous catgut suture.

After-Treatment. The patient is nursed in the prone or semi-prone position and the head is kept low. The dressings are left untouched for four or five days. The skin stitches are removed on the tenth day.

SECTION 3

SALIVARY GLANDS

THE two common surgical affections of the salivary glands are calculi with their sequelæ, i.e. fibrosis, fistula or abscess formation, and neoplasms, i.e. the mixed salivary tumours and carcinomata. Various other diseases affect the salivary glands, however, and are of surgical interest.

Injuries of the Salivary Apparatus. In practice these are confined to the parotid gland and Stensen's duct. The gland may be injured accidentally or during operations for glands in the upper part of the neck. The important structures traversing the gland may be involved in such wounds, notably the facial nerve, while hæmorrhage may be brisk. (See figs. 957 and 958.) Such wounds, unless infection takes place, heal normally and call for no special treatment. If infection is severe then a fistula is likely to result and will call for further treatment. An injury to Stensen's duct is more likely to be followed by a fistula than injury to the gland itself. Careful treatment will prevent this. The wound is excised and thoroughly cleansed, and the torn edges of the duct defined. A piece of thick silkworm-gut

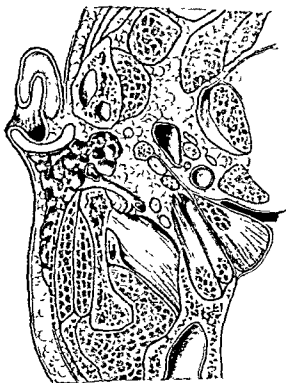


Fig. 957.—CORONAL SECTION THROUGH THE PAROTID GLAND SHOWING THE COURSE OF THE FACIAL NERVE.

is then threaded from the orifice of Stensen's duct at the level of the 2nd upper molar tooth and allowed to emerge from the distal cut end, where the gut is then introduced into the proximal cut end. Very fine catgut sutures are then passed to unite the cut ends of the duct (fig. 959). This method is successful in early cases if the duct ends can be mobilised sufficiently to allow approximation without tension. If apposition is impossible and the wound appears uncontaminated, then the proximal portion of the duct should be ligatured and the gland allowed to atrophy. If infection is present, however, this procedure will be followed by suppurative parotitis and fistula formation.

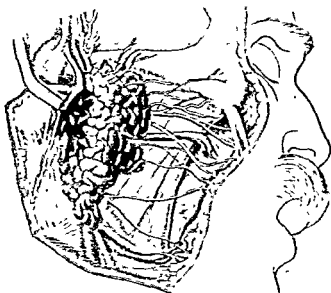


Fig. 958.—A DISSECTION OF THE SIDE OF THE FACE SHOWING THE RELATIONS OF THE FACIAL NERVE TO THE DUCT OF THE PAROTID GLAND.

An injury to the parotid duct may be followed by the formation of a cystic swelling at the site of the injury, pressure on such a swelling causing it to empty into the mouth.

Fistulae. The surgeon again is in the main concerned with the parotid gland and duct. Fistula of the submaxillary gland does occur, but usually heals spontaneously, if not, however, the gland may readily be excised. A fistula of Wharton's duct may occur into the mouth after removal of a stone, but it causes no disability and calls for no treatment.

Fistulae of the Parotid Gland. These follow infection of the gland, whether from wounds or after the drainage of acute suppurative

parotitis. The saliva discharges freely at meal-times. Suppuration may occur about a calculus and this lead to a fistula. If simple methods, such as scraping and cauterising the track, fail to cure the condition, then the only form of treatment is to stop secretion from the gland by either :

- (1) Avulsion of the auriculo-temporal nerve.
- (2) Radium therapy or deep X-ray therapy.

Sialography may be of value in suggesting whether the fistula communicates with a main duct.

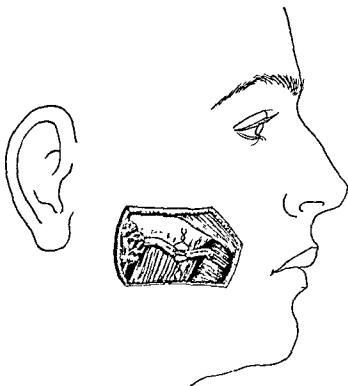


Fig. 359.—DRAWING SHOWING THE METHOD OF SUTURE IN CASES OF RECENT INJURY TO THE PAROTID DUCT. A PIECE OF SILEWORM-GUT ACTING AS A DOWEL.

Avulsion of the Auriculo-temporal Nerve. This operation will yield a certain cure in these cases, though not necessarily immediately. A section of the nerve supply to the gland is followed by a period of paralytic secretion. The reduction in glandular activity, however, is always sufficient to allow healing of the fistula. The paralytic secretion was observed to last as long as six years in one case. The fistula, however, had previously healed. The operation is readily performed under a local anæsthetic through a small vertical incision in front of the pinna. The superficial temporal artery is sought for and retracted, and the nerve is found immediately on its deep

aspect. The nerve is secured and divided, and the proximal end avulsed by winding on Spencer Wells forceps. The wound may be closed completely.

Fistulæ of the Parotid Duct (fig. 960). These may be classified as pre-masseteric or masseteric. These fistulæ follow wounds or suppuration.

Their treatment constitutes a nice surgical problem. Numerous operations, some highly ingenious, have been devised for relief of the condition, their chief drawback (apart from the main issue of success or failure to cure the fistula) being the risk of doing further damage, in particular to the facial nerve, transverse branch (see fig. 958). The disability is very real, as large quantities of limpid saliva pour over the face at meal times. The portion of duct in front of the fistula becomes stenosed and the problem, in part, is to get this reopened. Pre-masseteric fistulæ usually respond to the following procedure: A straight needle carrying a silk thread is passed through the fistulous opening into the mouth, and the needle withdrawn and re-threaded at the other end of the silk thread. The needle is again passed through the fistula into the mouth in a different direction, but in the line of the duct. The thread thus encloses

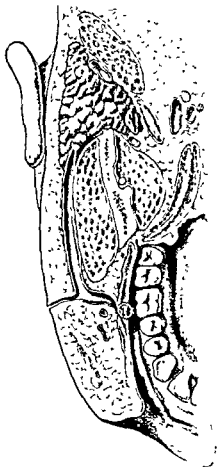


Fig. 960.—METHOD OF DEALING WITH A FISTULA OF THE PAROTID DUCT.

part of the tract and some mucous membrane of the buccal aspect of the cheek. The thread is then tied sufficiently tightly to cause strangulation of the included tissue, which sloughs out leaving a free opening into the mouth. Alternatively the whole fistulous tract can be freed in some of these cases and transplanted into the mouth.

Another reliable method is as follows: A fine probe is passed from the orifice of the duct along the proximal portion, and made to emerge in the fistula. A silk thread is tied to the probe which is then withdrawn. A piece of fine drainage tubing is secured to the silk and in

its turn drawn through, so as to leave both ends projecting, one on the cheek and one in the mouth. This dilates the proximal part of the duct. After three days the rubber tubing is gradually withdrawn completely. A new passage is then established and cure frequently follows. The method may, however, lead to some infection, in which case the tube should at once be withdrawn. If these methods are found unsatisfactory, or much sepsis is present, the best procedure is to paralyse the gland by either radio-therapy or auriculo-temporal nerve avulsion.

Infections of the Salivary Gland. Acute non-suppurative parotitis, epidemic parotitis, or mumps, is only of interest to the surgeon from its liability, especially in adults, to be followed by orchitis, and by occasional difficulty in diagnosis. Rarely the orchitis may be the primary condition and the parotitis secondary. No operative measures are required.

Simple parotitis occurs occasionally. It may be seen after exposure to cold or the exhibition of iodides or mercury, and also in cases of oral sepsis. The condition rapidly subsides on simple general treatment. Inflammation of the gland may follow irritation of the opening of the duct in the mouth by badly fitting dentures (fig. 961). Acute emphysema of the gland can occur in glass blowers, wind instrument

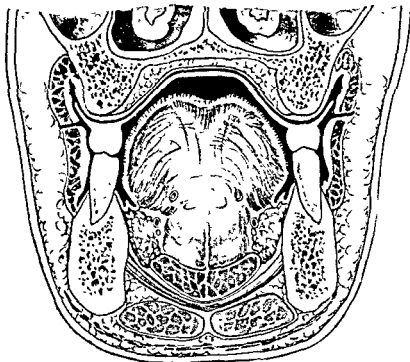


Fig. 961.—DIAGRAMMATIC DRAWING THROUGH THE MOUTH, SHOWING THE RELATION OF AN UPPER DENTURE TO THE ORIFICES OF STENSEN'S DUCTS.

players, etc., and has also been produced artificially by malingerers. The emphysematous appearance may be alarming, but it rapidly subsides in the course of a day.

Acute Suppurative Parotitis may either occur as a complication in the course of one of the severe exanthemata, or as a post-operative complication of operations usually on the mouth or abdomen. The condition is becoming uncommon, owing to greater care in oral hygiene, especially before major operations. It still occurs in asylums and in patients already debilitated by chronic disease, such as diabetes or nephritis.

The condition is a grave one, as, apart from the bad prognosis of the associated illness, infection may spread to the many veins in the

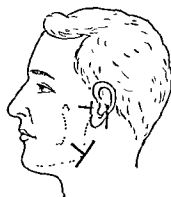


Fig. 962.—INCISIONS USED IN CASES OF SUPPURATIVE PAROTITIS.

gland, and lead to thrombosis of the internal jugular vein and pyæmia, while severe hæmorrhages may occur. The condition is likely to be followed by the formation of a salivary fistula. The initial symptoms are severe, pain is acute, and the patient cannot swallow, while fever and malaise are marked. The gland is very hard at first as its dense capsule of cervical fascia will not allow it to swell. The lymph glands draining it are swollen and tender. Suppuration occurs throughout the gland in scattered areas which may later coalesce. If unrelieved, this pus will burrow in the neck, into the temporo-mandibular joint or into the pharynx. Œdema of the glottis may occur. Treatment should be vigorous and early. The classical signs of suppuration should not be awaited, as they are masked by the firm gland capsule. Incisions are planned to avoid the branches of the facial nerve (fig. 962). Septa in the gland should be freely broken down. Frequent hot mouth washes and attendance to general hygiene is, of course, essential.

ACUTE INFECTIONS

Acute infections of the submaxillary and sublingual glands are not uncommon and are less serious than acute parotitis. The chief danger is the risk of œdema of the glottis or a spreading Ludwig's type of angina.

CHRONIC INFECTIONS OF THE SALIVARY GLAND

The only common chronic infection is a chronic, usually non-suppurative fibrosis in association with calculi. Tuberculosis of the parotid gland may co-exist with infections of the eye—uveo-parotid tuberculosis. Syphilis and actinomycosis may both affect the parotid. The interest to the surgeon is mainly one of diagnosis.

CYSTS

In children, bluish, thin-walled cystic tumours may occur in the floor of the mouth. These tumours, "ranulæ," were at one time thought to be retention cysts of the ducts of Rivinus, or even of Wharton's duct. It is more probable, however, that they are degenerative cysts of the glands of Blandin and Nuhn in the tongue. The swelling is painless and may from time to time empty itself in the



Fig 963.—LARGE RANULA IN AN INFANT PUSHING UP THE TONGUE.

mouth. It may suddenly swell up and seriously embarrass speech, deglutition, and even respiration. A congenital type occurs (fig. 963). They should be removed by dissection within the mouth. As much of the cyst wall as possible is removed (it is very friable), the rest destroyed by caustics and the wound allowed to heal up from the bottom.

SALIVARY CALCULI

Salivary calculi affect the submaxillary gland more frequently than the parotid in the ratio of three to one. Men are affected more frequently than women, and adults more than children. The calculi



Fig. 964.
"COMMA" CALCULUS
REMOVED FROM SUB-
MAXILLARY GLAND
AND DUCT.



Fig. 965.
CALCULUS REMOVED FROM
SUBMAXILLARY GLAND.



Fig. 966.
CALCULUS REMOVED
FROM SUBMAXILLARY
GLAND.

vary in size from wheat grains to stones the size of a date stone, while the duct stones are the size of a split pea. They may be found either in the gland or the duct or in both (figs. 964, 965, 966, 967 and 968). They contain a high percentage of calcium, and all but the smallest show up readily in an X-ray photograph (fig. 970). The stones may be multiple and faceted (figs. 971 and 972). They may include a foreign body as in figure 973.



Fig. 967.—CALCULUS REMOVED FROM
WHARTON'S DUCT



Fig. 968.—CALCULUS REMOVED FROM
WHARTON'S DUCT.

(Mr. Rodney Maingot's Case.)

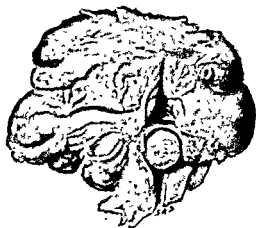


Fig. 969.—SPECIMEN OF SUBMAXILLARY GLAND IN WHICH A CALCULUS CAN BE EASILY SEEN.
(King's College Hospital Museum.)

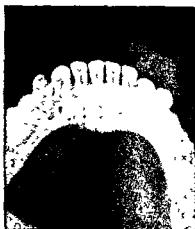


Fig. 970.—SKIAGRAM SHOWING A CALCULUS IN WHARTON'S DUCT.



Fig. 971.—SIX FACETED CALCULI REMOVED FROM THE SUBSTANCE OF THE SUBMAXILLARY GLAND. (SEE FIG. 972.)



Fig. 972.—THE COMPOSITE MASS OF SIX FACETED CALCULI FITTED TOGETHER WITH PLASTICINE AS THEY LAY IN THE SUBMAXILLARY GLAND. (SEE FIG. 971.)



Fig. 973.—CALCULUS FORMATION SURROUNDING A FISH BONE REMOVED FROM WHARTON'S DUCT.

(R.C.S. Museum, No. 2234, 1)



Fig. 974.—MIXED PAROTID TUMOUR IN A WOMAN
AGED 25 YEARS.



Fig. 975.—MIXED PAROTID TUMOUR IN A MAN
AGED 32 YEARS.

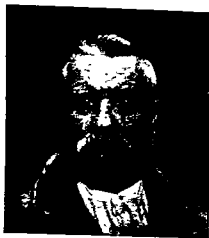


Fig. 976.—MIXED PAROTID TUMOUR IN A MAN
AGED 59 YEARS. THE TUMOUR IS SITUATED IN
THE LOWER PART OF THE PAROTID.

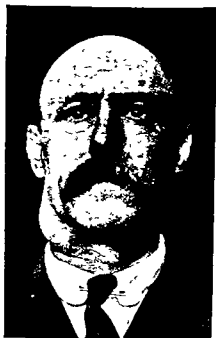


Fig. 977.—MIXED TUMOUR OF THE
SUBMAXILLARY GLAND.

TREATMENT

The stones should be removed. Some degree of infection always co-exists, and if the condition is neglected, an acute infection may supervene, an abscess form or even a fistula may occur.

In the parotid system the stones are usually in Stensen's duct, and only rarely are found in the gland. The duct is incised carefully in its long axis, the stone extracted and the duct irrigated, and finally its edges are approximated with fine sutures. Care should be taken to avoid damage to the transverse branch of the facial nerve.

Stones in the submaxillary gland cause fibrosis of the gland, and the whole gland should be excised. A stone which can be felt in the duct may be removed by an incision made through the floor of the mouth. Careful attention is, of course, paid to any existing oral infection.

TUMOURS OF THE SALIVARY GLANDS

Two types of tumour occur in the salivary glands, viz., the mixed tumour and carcinoma, and they both affect the parotid more frequently than the submaxillary gland. Secondary carcinomatous deposits in the lymph glands in close association with the salivary glands may, of course, involve the salivary glands, and in this case the submaxillary gland is affected far more frequently than the parotid due to the frequency of tongue growths.

The Mixed Tumour (figs. 974-984). These tumours are of great interest from pathological and therapeutic aspects. They may occur in any of the salivary glands, or in the mouth or palate, but are rare except in the parotid gland. They are benign at first, but later they become invasive, though metastases are rare (fig. 983). Section (figs. 986 and 987) shows an apparently heterogeneous collection of cells. Strands of epithelial cells are found, mucinous connective tissue, lymphoid tissue, and nævoid tissue. The "cartilage cells" of older descriptions are not true cartilage, but islands of epithelium in the midst of mucinous material. The tumour is probably a true adenoma and its "mixed" nature more apparent than real. The theories that it is due to branchial rests or a teratoma are unnecessary elaborations.

Treatment. The tumours should be removed. They are usually superficial in the parotid gland and may be shelled out, though some



Fig. 978.—MIXED TUMOUR OF THE SUBMAXILLARY GLAND. Fig. 979.—LARGE MIXED TUMOUR OF THE SUBMAXILLARY GLAND.



Fig. 980.—MIXED TUMOUR OF THE SUBMAXILLARY GLAND UNDERGOING MALIGNANT CHANGE.



Fig. 981.—MIXED TUMOUR OF PAROTID GLAND UNDERGOING MALIGNANT CHANGE, CAUSING FACIAL PARALYSIS.



Fig. 982.—CARCINOMA OF THE PAROTID GLAND.



Fig. 983.—ADVANCED CARCINOMA OF THE PAROTID GLAND.

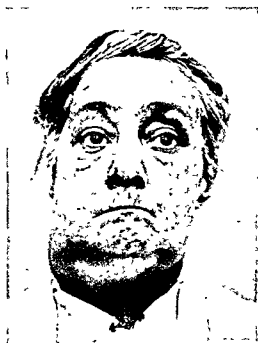


Fig. 984.—CARCINOMA OF THE SUBMAXILLARY GLAND.



Fig. 985.—SPECIMEN OF MIXED PAROTID TUMOUR
(NATURAL SIZE).
(King's College Hospital Museum.)

dissection may be necessary. The relation of the facial nerve to the tumour is variable, though usually it runs deeply to the tumour.

Carcinomatous tumours (figs. 982 and 983) may either affect the parotid gland as a primary typical adeno-carcinoma or be due to changes occurring in a long standing "mixed tumour." The former type metastasises early and differs in no way from an adeno-carcinoma elsewhere. The malignant changes in the "mixed tumours" are not so typical as metastases are unusual. The tumour is actively invasive, however. The patient's condition is pitiable in the later stages. Facial

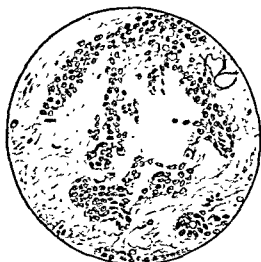


Fig. 986.—LOW POWER VIEW OF MIXED PAROTID
TUMOUR SHOWING AREAS RESEMBLING CARTILAGE.

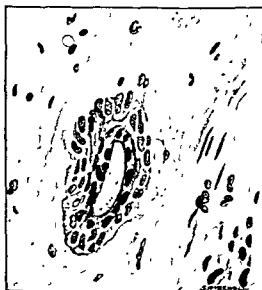


Fig. 987.—HIGH POWER VIEW OF MIXED PAROTID
TUMOUR ($\times 600$).

paralysis occurs, and may be the first sign of malignant change. Pain is severe, the skin may be involved and the tumour fungate and discharge saliva.

von Mikulicz's Disease. This is an uncommon condition where there is generalised enlargement of all the salivary glands and also of the lachrymal glands. It is of doubtful pathology, common theories being that it is due to a chronic infection or a benign form of neoplasm. The disease runs a chronic course, extending over many years. It is not of surgical interest, except from the aspect of diagnosis, and is only mentioned for the sake of completeness.

TREATMENT OF MALIGNANT PAROTID TUMOURS

This is far from satisfactory. The possible methods are :

- (1) Surgical removal.
- (2) Implantation of radon seeds.
- (3) Radium applications.
- (4) Deep X-ray therapy.

A combination of methods may be tried. Surgical removal is only practicable in the early case. No pains need be taken to spare the facial nerve as this has usually been destroyed by the growth. Hæmorrhage may be very profuse, and it is worth while detailing an assistant partially to occlude the carotid artery during the final stages.

A plastic operation (fascial grafting) should be attempted later to control the facial deformity.

Radium is best applied on a surface plaque. Nine 0.5 mgm. needles, six 1.0 mgm. needles, and eighteen 1.0 mgm. needles are required. A total dosage of 6000 mgm. hours is given.

X-ray Therapy in Parotid Lesions.

(a) *For Ptyalism* (excessive secretion). In this uncommon condition X-ray treatment is decidedly beneficial. Two glancing fields are used, one anterior, one posterior, practically parallel to the face. A medium voltage of about 130 kv. filtered by 3-4 mm. of aluminium is used. A total dose of 450 kv. (50-70 per cent V.S.D.) may be given at the first sitting.

(b) *For Parotid Fistula.* The same method as above is used, but one or two subsequent shorter treatments may be necessary.

(c) *For Malignant Tumours.* These are only occasionally highly sensitive to radiation. An additional vertical field should be added to the fields previously described. These tumours may be treated by a modification of Finzi's six-field method for radiating the entire neck.

Sialography. This consists of the radiographic demonstration of the ducts after the injection of lipiodol. Lipiodol injections may further be used as a therapeutic measure. A sialogram will readily demonstrate the ramifications of a fistula or the presence of cavities in a chronic parotitis. Half or one cc. of lipiodol is usually as much as can be injected without causing pain. A picture may be taken on a dental film after injection, or an ordinary lateral head picture be taken. The method is only of value in parotid lesions. It is safe and not obnoxious, though results may be difficult to interpret. Confusion is caused by lipiodol dropping into the mouth or spreading over the mucous membrane of the cheek.

The Technique of Excision of the Submaxillary Gland. The patient lies with a sand-bag underneath the shoulders, and the chin elevated and rotated away from the affected side. The anæsthetic is best administered through a pharyngeal or intra-tracheal tube. A curved incision concave downwards is made, starting a little below and to the affected side of the symphysis menti down to the lateral mass of the hyoid and then curving upwards. The platysma is incised in the line of the incision. The gland in its capsule will now be displayed. The capsule is best divided at the lower part of the incision with a transverse cut. The facial vessels run mainly behind the gland, but may be in very intimate connection with it. The vessels may be divided if necessary. The branch of the facial nerve to the platysma may be divided—this leads to drooping of the corner of the mouth, but this is only temporary. The gland is then lifted up and dissected off the mylo-hyoid muscle, working from before backwards. At the posterior end of the mylo-hyoid the gland passes deeply to this muscle, curving forwards again to the commencement of Wharton's duct. It may here be clamped and removed. The end of the duct is ligatured. The platysma should be sutured separately with fine catgut. If there is any capillary oozing, a fine drain should be left in the wound for 48 hours.

PART VII

NECK

by

SIR WILLIAM IRELAND DE C. WHEELER

NECK

WITH the development of specialisation in Surgery, operations in the region of the neck have become more limited. Radio-therapy has taken the place of radical procedures in many cases of malignant disease. Tuberculous glands are, as a rule, treated by conservative methods; foreign bodies impacted in the œsophagus and trachea, in the majority of cases, may be extracted through an œsophagoscope or bronchoscope.

There remains, however, an important residue of pathological conditions, some of which are death-dealing unless primarily treated by operative measures.

ANATOMY

It is not within the scope of this article to deal in detail with the surgical anatomy of the neck. It is, however, desirable to refresh the memory in connection with some of the more important landmarks and the relationships of some of the deeper structures. Operations of a serious nature will be approached by the experienced surgeon with either misgiving or complacency in accordance with the size of the neck. A procedure attended with little difficulty in a spare long-necked individual may be involved by grave risks in the fat, short-necked patient. The length of the cervical spine is constant and measures about 5 inches in the adult. The thoracic inlet, however, may be abnormally high or the muscles, especially the trapezius, may be over-developed or have a contour which makes the neck short and the approach to the deeper structures a matter of considerable difficulty. A high level of the shoulder girdle and general adiposity add to these difficulties.

Deep Cervical Fascia. The anatomical arrangement of the deep cervical fascia, with its prolongations and compartments, determines the localisation or the spreading of suppurative conditions. There is a large central compartment bounded in front by the pre-tracheal fascia, and

laterally by the fascia surrounding the great vessels. The compartment extends from the base of the skull into the posterior mediastinum, and from the hyoid bone into the anterior part of the superior mediastinum. This central or visceral compartment of the deep cervical fascia may contain pus arising from diseases of the structures it contains or may be the site of blood-borne infection. Abscesses secondary to cervical caries lie behind the pre-vertebral fascia and spread laterally in posterior relationship to the vascular compartment; such abscesses point behind the sterno-mastoid muscle. A small compartment of the deep cervical fascia lies in front of the large central or visceral compartment: it is known as the muscular compartment, and contains the depressor muscles of the hyoid bone. There is also a small supra-sternal compartment which contains the anterior jugular vein, fat and some lymphatic glands. The vascular compartment of deep cervical fascia contains the carotid vessels, the internal jugular vein, part of the vagus and the hypoglossal nerves, the descendens hypoglossi, and the upper portion of the spinal accessory nerve. The carotid chain of lymphatic glands in this compartment is in close relationship with the internal jugular vein. A spreading suppurative cellulitis arising in the vascular compartment extends towards the root of the neck and may reach the mediastinum or axilla.

Landmarks. Important landmarks may be seen or felt in the middle line. The recognition of these structures is required during almost every operation upon the neck. The hyoid bone can be readily palpated; the thyro-hyoid membrane lies immediately below. The median notch and the ridge joining the two *alæ* of the thyroid cartilage are superficial. The true vocal cords lie behind the centre of this ridge. On each side of the cartilage the lateral lobes of the thyroid gland can usually be detected. The crico-thyroid membrane can also be recognised between the cricoid and thyroid cartilages. The lower margin of the cricoid marks the junction of the larynx and trachea. The trachea sinks deeply into the neck in its course towards the thoracic inlet. At its origin below the cricoid it is crossed by the isthmus of the thyroid gland and cannot be palpated.

The supra-sternal notch lying between the sterno-clavicular articulations forms the lower limit of the structures in the middle line of the neck. The innominate veins lie behind the sternum in this situation, and the trachea is crossed by the innominate artery. In a child the left innominate vein sometimes lies at a high level and may be in danger during the operation of low tracheotomy. Ligature of the

innominate artery will be referred to later. On the right side the small fossa between the two heads of the sterno-mastoid muscle marks the position of the artery. The common carotid is found in a corresponding position on the left.

The external jugular vein crosses the sterno-mastoid muscle on a line which joins the angle of the jaw to the centre of the clavicle; it can be rendered prominent by digital pressure above the latter point. The centre of the posterior border of the sterno-mastoid marks the position where numbers of important nerves radiate in different directions. The great auricular nerve rises upwards towards the ear, deep to the external jugular vein. The superficial cervical nerve crosses the sterno-mastoid superficially. The supra-sternal and supra-clavicular nerves descend to their distribution. The spinal accessory is of more practical importance. It reaches the substance of the sterno-mastoid muscle, $1\frac{1}{2}$ inches below the tip of the mastoid process. It should always be exposed in removal of the carotid group of deep cervical glands. The course of the nerve can be delineated on the surface by a line drawn from a point midway between the tip of the mastoid process and the angle of the jaw to the middle of the posterior border of the sterno-mastoid muscle. The nerve passes backwards in the posterior triangle of the neck to reach the trapezius muscle.

In the higher regions of the neck the upper portion of the anterior triangle is termed the digastric triangle and contains the submaxillary gland. The facial vein is superficial to the gland, the facial artery is embedded in its deep surface. By raising the submaxillary gland from its bed, the hyoglossus muscle is approached, on the surface of which lie the hypoglossal nerve and the lingual vein. Division of the fibres of the hyoglossus muscle will expose the lingual artery in relationship to the great cornu of the hyoid bone. The hyoglossus muscle forms the central portion of the floor of the digastric triangle; the mylo-hyoid lies in front and the superior constrictor of the pharynx behind. Thus the floor of the digastric triangle is formed from before backwards by the mylo-hyoid, hyoglossus, and superior constrictor. The lymphatic glands contained in this space drain the face and mouth including the tongue and teeth. Suppurative cellulitis of the tissues in this space is known as Ludwig's angina (see page 1897).

Posteriorly in the middle line of the neck, 2 inches below the external occipital protuberance, the spines of the atlas and axis can be felt. The former is a guide of importance. The injection of fluids opaque to X-rays for the localisation of tumours of the spinal cord,

or the introduction of tetanus antitoxin into the cisterna magna is made above this bony landmark. The cistern lies in front of the occipito-atlantoid ligament at a depth of 4.5 to 6 cm. in the adult. The centre of a line joining the tips of the mastoid processes is the point for introduction of the needle. Before entering the cistern the strong atlanto-occipital ligament is pierced by the needle. A free flow of cerebro-spinal fluid indicates the correct position of the needle.

MUSCLES OF THE NECK

For the purposes of practical surgery only a few muscles need special mention. The sterno-mastoid muscle is superficial and obvious. It arises from the manubrium sterni and from the inner third of the clavicle, it gains insertion into the mastoid process and the superior curved line of the occipital bone. It is the separating line between the anterior and posterior triangles.

The platysma forms the thin sheet of superficial muscle tissue extending over the side of the neck from the face to the chest. It has a certain importance during the closure of incisions in the neck. It should be carefully and separately sutured in order to prevent infolding of the skin edges. Accurate suture also prevents subsequent stretching of the scar. Many operations can be performed by vertical splitting of the fibres of the platysma without division. Whenever possible this should be done during the operation for goitre.

The infra-hyoid muscles are landmarks in many surgical exposures. Thus the common carotid artery is ligatured for choice above the anterior belly of the *omo-hyoid*.

The *omo-hyoid* is a double-bellied muscle. The posterior belly arises from the scapula and takes the form of a narrow muscular band, passing upwards and forwards beneath the sterno-mastoid. In this situation it becomes tendinous and then again muscular, to form the anterior belly which extends upwards for insertion into the body of the hyoid bone. The anterior belly crosses the common carotid artery at the level of the cricoid cartilage. The sterno-hyoid muscle lies superficially in the anterior triangle in front of the sterno-thyroid. The right and left muscles meet in the middle line. The sterno-thyroid lies beneath the sterno-hyoid and is a shorter and somewhat broader muscle. These muscles spread themselves out over goitres and other tumours in this region of the neck. They must be divided transversely

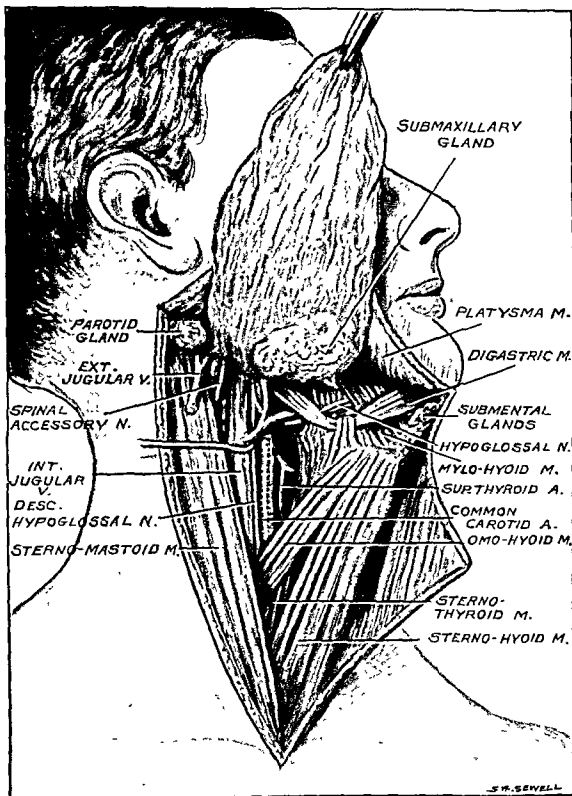


Fig. 938.—DEEP ANATOMY OF THE NECK AS SEEN AT THE OPERATION FOR BLOCK DISSECTION OF THE LYMPHATICS.
 (After Thomson and Miles.)

at a high level or widely retracted for the deliverance of a tumour. High division is essential in order that the nerve supply may be preserved.

Amongst the supra-hyoid group of muscles, the digastric and hyoglossus are of most surgical importance. The posterior belly of the digastric arises beneath the mastoid process. It is directed downwards and forwards to the body of the hyoid bone, to which it is connected by a pulley-like band of cervical fascia. The anterior belly is directed from this band upwards towards the chin, to be inserted into the mandible near the symphysis. The muscle forms the front and back boundaries of the submaxillary space.

The position of the hyoglossus muscle has already been mentioned.

The insertion of the scalenus anticus to the first rib forms an important landmark in operations on the subclavian artery and the neighbouring nerve trunks. The scalenus anticus arises from the transverse processes of the 3rd, 4th, 5th and 6th cervical vertebrae. It passes down behind the carotid sheath for insertion into the scalene tubercle and ridge on the first rib. In front of the muscle lie the subclavian and internal jugular veins; behind, it is separated from the scalenus medius by the trunks of the brachial plexus, the subclavian artery, and the pleura. The phrenic nerve, which requires evulsion in order to paralyse the corresponding dome of the diaphragm in selected cases of pulmonary tuberculosis, descends with an inclination inwards upon the belly of the muscle. The supra-scapular artery, and higher up the transversalis colli artery, overlie the muscle.

Tenotomy of the scalenus anticus relieves the vascular or nerve compression produced by cervical ribs, or the compression sometimes produced by the normal first rib. The difficulties attending rib resection are avoided by this operation. The muscles in the posterior region of the neck will be mentioned in connection with ligature of the left subclavian artery (see page 1952).

From the point of view of the operating surgeon it is only necessary to add to this superficial survey of applied anatomy by mention of the thoracic duct, the œsophagus, the recurrent laryngeal nerve, and the general arrangement of the lymphatic glands.

The thoracic duct extends upwards into the neck one inch above the inner end of the clavicle on the left side. It curves upwards behind the common carotid artery and descends in a loop behind the lower portion of the internal jugular vein. The duct may be accidentally divided. Owing to free collateral communication with the venous system usually it is not a fatal accident. Ligature at the time of

division or subsequent compression with pads is indicated. If the discharge of chyle persists, an attempt should be made to insert the open end of the duct into the external jugular vein (Harrison).

The cervical portion of the œsophagus commences at the level of the cricoid cartilage and descends behind and slightly to the left of the trachea.

The position of the recurrent laryngeal nerve must be remembered; it lies in the groove between the œsophagus and the trachea. This nerve is in danger during operations upon the thyroid gland. It is in relationship to the inferior thyroid artery which reaches inwards in front of the nerve.

Lymphatic Glands. The lymphatic glands in the neck are involved to a greater or lesser extent in all but the earliest of malignant and infective conditions. The superficial cervical glands are found in relationship to the external jugular vein. They can be felt along the posterior border of the sterno-mastoid muscle. A group of these glands lie in the submaxillary region in relationship to the superficial and deep aspects and to the substance of the submaxillary gland. Two or three supra-hyoid glands are situated beneath the chin between the anterior bellies of the digastric muscles. A few glands lie on the mastoid process behind the ear and a few in front in relationship to the parotid. The deep cervical glands are found along the course of the internal jugular vein; an upper group extends from the base of the skull to the point of bifurcation of the common carotid artery. The lower group follows the subclavian vein and extends into the lower portion of the posterior triangle of the neck. Block removal of all these glands is practised in cases of malignant disease (see fig. 988).

Sometimes large malignant tumours arise from the lymphatic glands. In the case illustrated (figs. 989 and 990) the tumour moved freely as if encapsulated. The swelling had been present since childhood, but had grown more rapidly some months before the patient was seen. It was at first thought to be cystic, but did not trans-illuminate



Fig. 989.—LYMPHATIC ENDOTHELIOMA.
(Wheeler, *Med. Ann.*, 1931.)

and an exploring needle and syringe found blood only. At operation an encapsulated vascular tumour resembling a goitre in appearance was removed from the deeper structures of the neck.



Fig. 990—TUMOUR SEEN IN FIG. 989 AFTER REMOVAL.
(Wheeler, Med. Ann., 1931.)

Microscopically, it was regarded as a lymphatic endothelioma originating in the cervical lymph nodes. These tumours grow more slowly than the lympho-sarcomata.

One of the small attached lymph nodes showed evidence of a tuberculous infection.

OPERATIONS

Pre-operative preparation will vary in accordance with the nature of the case. Suffice it to say that in the region of the neck as in other regions the pre-operative and post-operative management often is more important than the operative procedure. No operation on the neck should be attempted in the presence of oral sepsis.

Preparation of the Operation Area. A suitable anæsthetic screen or cage should be employed in order to shut off from the operation area the patient's head and face, together with the anæsthetist and apparatus.

When extensive operations upon the neck are contemplated, the orthodox face screens, fixed to the operating table, embarrass the movements of the surgeon's hands and he is cramped for space when making high dissections.

A simple face screen which is fixed to the patient's head before the toilet of the neck is commenced is shown in figures 991 and 992.

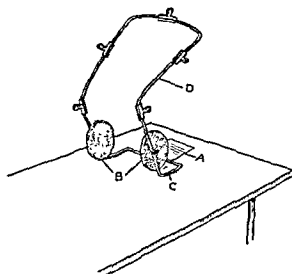


Fig. 991.—WHEELER'S FACE SCREEN. A. Plate for sand-bag. B. Circular Pads to grasp Head about the Ears. C. Hinged Frame. D. Wire Screen.

A towel is placed round the patient's head and over this the screen is placed in position. The pads attached to the screen are applied firmly over the region of the ears. The wire portion can be tilted backwards towards the head to any required extent without interfering with the inlet of air.

The entire neck is now washed with methylated spirit by means of a swab held in a pair of forceps. The skin dries and Harrington's solution is then applied, care being taken that none of this latter

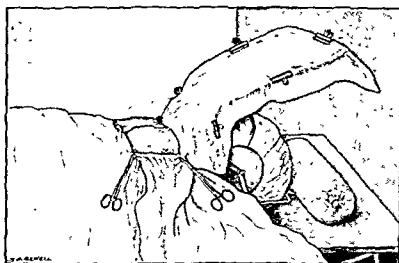


Fig. 992.—WHEELER'S FACE SCREEN. The towels are in position. The sand bag is seen on the plate above the head.

solution trickles back behind the neck and shoulders, as it may excoriate the skin.

The head is lifted by the front hair from the table by a nurse. Two sterilised sheets, one on top of the other—each about twice the size of an ordinary hand towel—are passed under the head and neck. The uppermost is wrapped round the head and the base of the anæsthetic screen; it is fastened by a towel clip at the level of the root of the nose. The undermost sheet is then carried over the shoulders like a shawl. A large fold of sterilised gauze is thrown over the screen and held in position by paper clips or suitable forceps. The patient is covered over with a large sheet which meets the shawl-like folds of the neck towel over the shoulders. The operation area is left well exposed. The patient's head can be turned from side to side by the anæsthetist with the screen *in situ*.

For almost all operations on the neck, a small sand-bag is placed under the shoulders so that the hyper-extended position may be obtained. More room is secured on the affected side by drawing the arm well downwards and fixing the wrist by a padded clove hitch to some portion of the operating table.

A generous incision should always be made in order to get free exposure of the deeper structures, and whenever possible the incisions should be made in a transverse direction. When transverse incisions follow the folds of the skin the resultant scar is almost invisible.

The skin and deep fascia are dissected upwards and downwards to give adequate exposure of the deeper structures. "Side-curtains" of towel or tetra-cloth are attached to the skin edges. These are held in position by small curved hæmostatic forceps which clip the edges of the towel to the subcutaneous tissue. The skin edge is not included in the bite of the forceps. The heavier types of towel forceps are unsuitable for operations about the neck. If it is expedient to make a large skin flap above, as in the case of goitre operations, it may be held upwards by fixing it with forceps to the gauze which covers the anæsthetic screen. After prolonged and deep dissections, a small rubber drain may be inserted through a conveniently placed stab wound. The deep fascia and platysma (if divided) should be carefully sutured, as the subsequent cosmetic result depends upon the accuracy of this procedure. Michel clips are used for the approximation of the skin. They should not be squeezed too tightly when inserted, and they may often be removed on the second day. If any tension exists a continuous mattress stitch (Halsted's) of very fine Japanese fishing gut is preferable.

A light gauze dressing and a thin layer of wool cover the incision and are held in position by a collar of two strips of elastoplast, each passing round to the back of the neck. No further dressing is needed in a simple case, but where drainage is applied more wool and a surrounding bandage are usually necessary. The bandage should pass in a figure-of-eight fashion round the neck and axilla, and be continued upwards over the top of the head, terminating in a few turns round the forehead which pass below the occiput behind. An extensive bandage of this kind protects the wound and acts as a splint for the head. It is, however, hot and uncomfortable, and usually unnecessary.

After all operations on the neck, the patient should be carefully watched until consciousness and reflexes return; cases of asphyxiation are recorded from the sudden falling back of the tongue and jaw.

ANÆSTHESIA

In the experience of the writer local infiltration alone or combined with colonic oil-ether anæsthesia is ideal for operations in the regions of the head and neck. There are many alternatives, but these will not be discussed.

LOCAL ANÆSTHESIA

A hypodermic injection of morphia $\frac{1}{8}$ – $\frac{1}{4}$ gr. with atropine $\frac{1}{100}$ gr. is given prior to the commencement of anæsthesia in every case. Local anæsthesia is employed for choice by the infiltration method. *Novocaine* in $\frac{1}{2}$ –1 per cent solution or *percaine* in $\frac{1}{1,000}$ – $\frac{1}{2,000}$ solution are recommended. Adrenalin is added except in the case of toxic goitres when it is better avoided. Among the many advantages of local anæsthesia in operations about the neck are the following:

- (1) The patient can, to some extent, control bleeding from large veins by taking a deep inspiration and thus producing a negative pressure.
- (2) When the recurrent laryngeal nerve is in danger, the patient may be asked to phonate.
- (3) Vomiting, with possible infection of the wound, is obviated.
- (4) When using the cautery, there is no danger from an anæsthetic explosion.

The skin and the cervical fascia are the most sensitive structures.

Technique. A fine needle, 3-4 inches long, is inserted under the skin in a line corresponding to the proposed incision. It is ascertained that no blood emerges from the needle before the solution is introduced. The solution is injected as the needle is slowly withdrawn. The point of the needle is directed towards the deep surface of the skin. 10-20 cc. of the solution is used for this first injection. Many operations such as the removal of a simple goitre may be performed with this superficial anæsthesia; but it is an advantage to plunge the needle deeply into the areas where deep manipulations are expected. For example, it may be introduced for a couple of inches towards the deep structures of the neck in the region of the

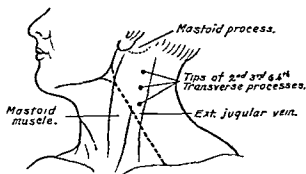


Fig. 993.—BLOCK ANÆSTHESIA OF THE LEFT SIDE OF THE NECK.
(After Mayo.)

superior thyroid pole and 5-10 cc. of the solution injected. The only precaution necessary is the avoidance of perforation of a blood-vessel.

Some surgeons prefer a more accurate block of the cervical plexus. If a line be dropped vertically from the tip of the mastoid process downwards for about 7 cms. and in a backward direction, it marks the point of exit of the 2nd, 3rd, and 4th cervical nerves. A needle inserted deeply along this line will usually strike a transverse process—it is felt with the point of the needle; the depth of insertion should not be more than $\frac{1}{2}$ inch beyond this point. The injection is made deeply both upwards and downwards (fig. 993). The jugular vein and the carotid artery lie well in front and are not in danger. Complete anæsthesia of the lateral half of the neck can be obtained by this method; about 20 cc. of solution is required for each side.

It is important to keep the needle moving constantly while the injections are being made, in order to avoid any possibility of making them directly into the blood stream.

The writer does not employ the block method; superficial and

deep infiltration in the operative area has proved adequate if sufficient time is given for the solution to take effect.

In cases of tuberculous glands, sepsis, or malignant disease, local infiltration anæsthesia should not be attempted; colonic oil-ether will be found admirable.

TECHNIQUE OF COLONIC OIL-ETHER ANÆSTHESIA

This will be described in some detail as there is not sufficient acquaintance with the modern methods of administration. When properly administered it is free from danger and there are no untoward symptoms.

The patient is weighed. Weight is the governing factor in regard to dosage. The average strength of the mixture is 50 per cent of ether in olive oil; 60 per cent solutions may be used in strong, robust patients. 1 oz. of the solution is employed for every 20 lb. body weight; thus, a patient weighing 10 st. receives 7 oz. of the mixture. A mixture of ether 100 cc., olive oil 75 cc. and oil of camphor 20 cc. has been recently recommended (Novel).

The bowels should be washed out the night before operation. The anæsthetic should be given for choice in a quiet corner of the ward or in a separate room. On an average it takes three-quarters of an hour to produce satisfactory anæsthesia.

The introduction of the solution into the rectum is preceded by a hypodermic injection of morphia and atropine. A rubber catheter is passed as high as possible into the rectum without kinking and is attached to a tube and funnel. The patient lies on his side in bed. (He should never be placed on the trolley before the injection is given.) The solution is permitted to run in through the catheter very slowly, almost drop by drop, and it should take at least twenty minutes to introduce the entire amount. The tube and funnel are then disconnected from the catheter and the latter is closed with a spigot or forceps. Movements of the patient or noise in the ward, or disturbance of any kind during the course of anæsthesia breaks the syndrome and hinders the quiet transition from consciousness to sleep. After half an hour or forty minutes, if the patient is not sufficiently anæsthetised, a few drops of ether inhaled from a mask will tip the balance. The anæsthesia gets lighter as time goes on, but for at least an hour remains complete. Very occasionally a little oral inhalation becomes necessary at the close of the operative procedure.

At the completion of operation, before the patient is removed

from the theatre, the bowel is thoroughly washed out by syphonage through the catheter, and 3-4 oz. of olive oil are injected into the colon. The patient remains in a state of analgesia for some hours. There is never any ground for post-operative anxiety, and sisters and nurses familiar with the method prefer it to more recent innovations in the field of anæsthetics.

Amongst the many advantages of colonic anæsthesia are its pre-eminent safety, the comparative absence of chest complications, and the fact that there is no anæsthetist or bulky apparatus in the area of operation. The one disadvantage is the length of time it requires to induce anæsthesia, but apart from emergency conditions time saving should never be a paramount consideration in the realm of surgery.

CELLULITIS

The most serious form of cellulitis of the neck arises beneath the deep cervical fascia. Usually the condition starts from sepsis in the mouth or throat. The infection spreads through the lymphatics into the cellular tissue of the neck. The infective products are held tightly under tension by the unyielding deep cervical fascia and tend to track towards the mediastinum or along the subclavian vein into the axilla.

Serious complications arise in the course of septic cellulitis of the neck, amongst which may be mentioned empyema, mediastinitis, pericarditis, œdema of the glottis and venous thrombosis. Pyæmia and more remote consequences such as cerebral abscesses may also follow. Extensive sloughing and secondary hæmorrhage arise in neglected cases.

The administration of anæsthetics by routine methods is dangerous. Spasm, mucous secretions, and resultant cyanosis may be encountered. Ether in any form is to be avoided in cases where danger from asphyxia already exists. Probably the safest anæsthetic is a mixture of oxygen and chloroform, although the latter is contra-indicated in most septic conditions.

Operation. The swelling is usually diffuse and brawny. The incisions should be made in a transverse direction where maximum tenderness is found. It is advisable to proceed by Hilton's method, i.e. exploring the deeper tissues with the nose of hæmostatic or sinus forceps. More than one incision is frequently necessary. Free drainage is established by strips of rubber tissue; stiff rubber tubes sometimes

promote secondary hæmorrhage. A tracheotomy or laryngotomy tube should be always at hand as respiratory embarrassment may occur during the course of the anæsthetic. The writer has been present when death occurred from suffocation in a case of a short-necked florid individual. In this case ether was administered in the patient's bedroom, a knife and a few forceps alone were prepared to relieve tension and to search for pus, the patient rapidly became cyanosed and died in a few minutes. Surgery should not be attempted in cases such as this unless every preparation and precaution has been taken beforehand to meet a sudden emergency.

LUDWIG'S ANGINA

In this condition the tissues in the region of the submaxillary gland become infiltrated with infective material. There is a diffuse tense swelling beneath the jaw and in the floor of the mouth. The condition is, in fact, a localised virulent streptococcal cellulitis. The mucous membrane on the floor of the mouth is greatly swollen and the tongue is pushed upward. Extensive sloughing may take place. Asphyxia may occur if the process extends deeply towards the larynx. Ulceration is sometimes followed by severe secondary hæmorrhage.

Operation. Sudden œdema of the glottis may call for immediate laryngotomy or tracheotomy, and the surgeon should once again be prepared for this emergency. As in more generalised septic cellulitis of the neck, the anæsthetic question is of great importance. There is *less danger of respiratory embarrassment from chloroform anæsthesia* than from other methods, but cervical block with a local anæsthetic is an alternative. Infiltration anæsthesia is contra-indicated. A free incision should be made across the swelling just below the mandible; it extends from the middle line outwards parallel to the jaw. The facial artery may need division and ligature. The mylo-hyoid muscle is recognised whenever possible and divided. By division of this muscle Hamilton Bailey points out that the region is decompressed and the danger of the pus tracking deeply to the vital area is circumvented. In urgent and severe cases it may only be possible to divide the superficial structures and to penetrate the deeper planes by a blunt dissector or sinus forceps; the facial artery and troublesome hæmorrhage may be thus avoided.

In early cases a free incision is made deeply in the middle line from the symphysis menti to the hyoid bone. There are no anatomical

structures of importance in the line of this incision. A pair of forceps is passed upwards to the floor of the mouth and the blades are divaricated. In some cases when the cellulitis is tracking from one side to the other the transverse and vertical incisions are made simultaneously. Dressings saturated in hygroscopic solutions should be applied. The most suitable applications are stupes of hypertonic sodium chloride, saturated magnesium sulphate, or 10 per cent solutions of glycerine and ichthyol. Sometimes a condition analogous to Ludwig's angina arises in the lower portion of the neck. The pus may be reached by an incision along the lower two-thirds of the anterior border of the sterno-mastoid muscle. Hilton's method is again indicated. In all such cases polyvalent anti-streptococcal serum should be employed. In most cases of septic cellulitis of the neck there is an uninterrupted convalescence after free drainage has been secured, but there is always a potential danger of complications such as have been mentioned already (see page 1896). Sometimes the mere change of the rubber tissue draining the area appears to determine the onset of remote septic complications. These drains should not be disturbed for several days.

PHARYNGOTOMY

The upper portion of the pharynx may be approached through the mouth or by division of the lower jaw through the middle line. In the neck the cavity can be reached above or below the hyoid bone or laterally by exposing and dividing the constrictor muscles.

INFRA-HYOID PHARYNGOTOMY

An incision 4 inches in length is made transversely beneath the hyoid bone. The platysma is divided together with the sterno-hyoid, omo-hyoid and thyro-hyoid muscles. The strong thyro-hyoid membrane covered by the thyro-hyoid bursa is next opened in the line of the incision. It is unwise to divide the membrane too close to the hyoid as subsequent suturing will be rendered difficult. Division of the membrane too near the thyroid cartilage may wound the internal laryngeal nerves. Some fatty tissue is now encountered, but the epiglottis can usually be found without difficulty near the central notch of the thyroid cartilage. By retracting the hyoid bone upwards with a hook and deepening the wound in an upward direction, the mucous membrane at its reflection from the tongue to the epiglottis can be located and opened. The epiglottis is now freely exposed and can be

drawn through the wound. Its removal may be indicated by invasion of a growth. A limited growth within the pharynx can be dealt with by excision or fulguration through this exposure. The wound is closed in layers, the mucous membrane is first sutured, then the margins of the thyro-hyoid membrane, and finally the infra-hyoid muscles and the skin.

Higher exposure may be obtained by *supra-hyoid pharyngotomy*. The incision extends above the hyoid bone from one sterno-mastoid muscle to the other. After division of the superficial tissues, the submaxillary glands come into view and their lower borders are retracted upwards. The mylo-hyoid muscles are detached from the hyoid bone and the incision is carried through the deeper layer of muscles. The buccal cavity is reached in front of the epiglottis. This incision gives good exposure of the pharynx in the region of the base of the tongue and the tonsils.

LATERAL PHARYNGOTOMY

This operation is recommended when malignant disease within the pharynx is coupled with metastases in the deep cervical glands below the angle of the jaw. The glands may be removed as a preliminary operation and the growth in the pharynx dealt with subsequently, but in many cases the operation can be performed in one stage. The procedure described below is indicated for growth below the level of the hyoid bone. A preliminary tracheotomy is necessary.

An incision is made in front of the sterno-mastoid muscle from a point corresponding to the greater cornu of the hyoid bone downwards for 4 inches. The sterno-mastoid muscle is exposed and retracted, together with the great vessels. The anterior belly of the omo-hyoid muscle in the lower portion of the wound usually requires division. The superior pole of the thyroid gland with its vessels is ligatured, divided, and retracted. The inferior constrictor muscle of the pharynx is now exposed and is made tense by rotating the larynx to the opposite side. The thyroid gland is displaced downwards. The wall of the pharynx is divided in the long axis of the wound, behind the ala of the thyroid cartilage. A finger is introduced into the pharynx and the extent of the growth is estimated. Removal is accomplished by fulguration or excision. The wound is closed layer by layer. Drainage should be provided for.

After operation there is difficulty in swallowing, and the administration of nourishment must be carried out through a nasal tube passed

into the stomach. The tracheotomy or laryngotomy tube is removed after 24 hours.

Two serious complications may arise: first, septic pneumonia; second, local sepsis in the wound. The incidence of septic pneumonia is lessened by carefully cleansing and disinfecting the mouth before operation and by the preliminary performance of laryngotomy or tracheotomy. Sepsis in the wound may give rise to acute cellulitis and possibly to secondary hæmorrhage. Free drainage and B.I.P.P. lightly smeared over all the exposed tissues before inserting the closure sutures are probably the best means of avoiding this complication.

TROTTER'S OPERATION

In performing lateral pharyngotomy, Trotter recommends in some cases a very extensive operation. If the upper part of the pharynx is

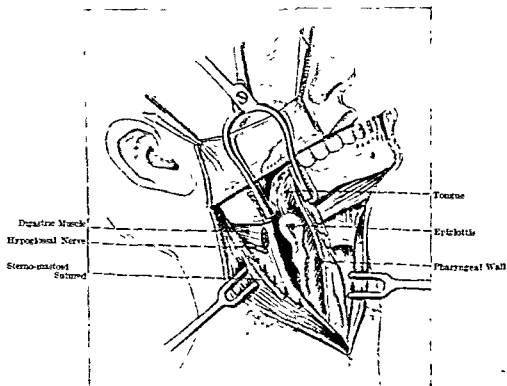


Fig. 934.—TROTTER'S LATERAL PHARYNGOTOMY.

(Carson's *Modern Operative Surgery*.)

involved, division of the mandible in front of the masseter is desirable. The great cornu of the hyoid bone and the ala of the thyroid cartilage are removed in order to secure free division of the middle and

inferior constrictors. By such a wide dissection the upper opening of the larynx and the cervical portion of the œsophagus can be readily exposed. Trotter's operation is referred to as combined laryngo-pharyngotomy. It includes preliminary tracheotomy. Incisions are made from the ear to the cricoid cartilage along the anterior border of the sterno-mastoid muscle and through the middle of the lower lip along the under-surface of the jaw to join the first incision. The posterior belly of the digastric together with the stylo-hyoid muscles and the superior thyroid, lingual and facial arteries are divided. An important step in the operation is the suture of the sterno-mastoid muscle to the pre-vertebral muscles in order to isolate the carotid region from the area of the pharynx. This manœuvre is employed in order to minimise the danger of deep septic cellulitis of the neck. The superior laryngeal, lingual, and hypoglossal nerves also require division. The latter is sutured before the completion of the operation. It is claimed that the anterior and lateral wall of the pharynx can be thus incised without encroaching upon the growth. The operation is not followed by considerable shock. Sometimes the permanent use of a tracheotomy tube becomes inevitable.

Comments. Pharyngotomy. Operative surgery on the pharynx has distinct limitations. Treatment by radio-therapy has to a large extent taken the place of radical operative procedures in malignant cases. Rare conditions, such as pharyngocele, high diverticulum of the pharynx and the removal of foreign bodies which cannot be extracted through the mouth, require operation. Of the malignant tumours, lympho-sarcomata and squamous-celled epitheliomata are the most common. The latter are sometimes miscalled endotheliomata and branchogenic carcinomata. In early cases of pharyngeal neoplasm, the signs and symptoms are often very obscure; sometimes enlarged cervical glands are the first indication of a growth. Secondary lesions of the cranial nerves may call attention to its presence.

Diathermy is probably the best method for destruction of the growth; it can be either coagulated or excised by this method. For coagulation a small button-shaped electrode is used and the resulting necrosed portion removed with a curette. Excision may be performed by a diathermy knife or needle. The button is afterwards applied to the resultant cavity. The destruction or removal of the growth is bloodless but may take half an hour to perform. For obvious reasons diathermy is better than an extensive cutting operation.

FOREIGN BODIES IN THE PHARYNX

These cases may be very urgent. A child may swallow a coin which lies transversely, or a large lump of food may block the lumen of the canal and cause pressure on the larynx or trachea. A finger carried through the mouth into the pharynx to the back of the epiglottis may dislodge and extract such a foreign body. If this fails, no time should be lost in performing tracheotomy. Apart from such urgent cases, the first step necessary is to make sure that the foreign body actually is present and to ascertain its position by X-ray photographs. As already pointed out, most foreign bodies can be extracted through the œsophagoscope.

ŒSOPHAGOSCOPY

Some years ago Bland-Sutton referred to the œsophagoscope as an instrument requiring the instinct of a sword swallower and the eye of a hawk. It is now in use as a routine means of examination. The procedure is indicated during the treatment of strictures, for the removal of foreign bodies, for the insertion of radium, and to assist the exposure of the œsophagus during operation.

Colonic oil-ether anæsthesia, or painting the pharynx and the larynx with 10 per cent cocaine and adrenalin solution, will be found suitable. The head and neck are hyper-extended, and a gag is inserted. The instrument is passed along the side of the tongue and directed towards the pharyngeal wall. At the level of the cricoid cartilage there is a constriction, but with practice the instrument can be readily passed into the œsophagus and a clear view obtained.

Occasionally the foreign body is hidden by folds of mucous membrane or lies closely embedded in the œsophageal wall and cannot be visualised. In the event of failure to remove the obstacle by means of the œsophagoscope, œsophagotomy must be performed. This procedure may be undertaken while the œsophagoscope is in position. The œsophagus is thus rendered prominent and can be readily identified (see fig. 997).

ŒSOPHAGOTOMY

The neck is hyper-extended by means of a large sand-bag under the shoulders, or the head is allowed to hang over the edge of the table. The incision is made on the left side along the anterior border of the sterno-mastoid muscle from the inner end of the clavicle to the

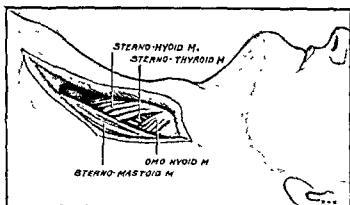


Fig. 995.—CESOPHAGOTOMY. DEFINITION OF THE MUSCLES.

(After E. H. Taylor.)

upper border of the thyroid cartilage. The sterno-mastoid muscle is defined and retracted. The pre-tracheal muscles are exposed and retracted mesially. The pre-tracheal layer of the cervical fascia comes into view and is divided. The lateral lobe of the thyroid gland is dislodged and retracted towards the right. In most cases the inferior thyroid artery passing inwards from behind the common carotid artery towards the middle of the thyroid gland will require ligation and division. The *oesophagus* is found between the trachea and the cervical vertebræ (figs. 995 and 996). The operator should be equipped with a good head-light which allows the musculature of the *oesophagus* to be readily identified. The *oesophagus* is grasped by two pairs of tissue forceps and divided layer by layer by a vertical incision. The incision should lie near the vertebral aspect of the tube so as to avoid the recurrent laryngeal nerve. The incision in the *oesophagus* is best made above the foreign body in a healthy portion of the wall. The foreign body is extracted with suitable forceps. After its removal the mucous membrane and muscular walls are sutured separately whenever possible. A drainage-

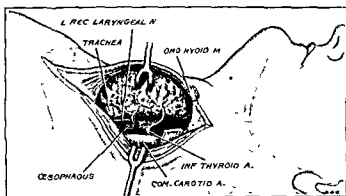


Fig. 996.—CESOPHAGOTOMY. THE INFERIOR THYROID ARTERY IS DIVIDED. THE GLAND IS DISPLACED MESIALLY.

(After E. H. Taylor.)

tube or a strip of rubber tissue is passed down to the level of the sutures in the œsophagus.

The writer has seen a case in which a wedge-shaped dental plate, measuring $3\frac{1}{2}$ cms. across the base and 3 cms. from the apex to the base, was swallowed two and a half months before the patient sought surgical advice. The denture was lodged just below the supra-sternal notch at a level corresponding to the summit of the aortic arch. It was embedded in the wall of the œsophagus so that there



FIG. 997.—DENTAL PLATE IMPACTED IN THE OESOPHAGUS FOR TWO AND A HALF MONTHS.

(Wheeler, *Med. Ann.*, 1931)

was no difficulty in passing the œsophagoscope beyond it and no difficulty was experienced in taking food; in fact, there were no clinical symptoms. The denture could not be seen with the œsophagoscope, but with this instrument in position the œsophagus was exposed and it was thus rendered prominent and easily identified. The thyroid gland was retracted upwards exposing the recurrent laryngeal nerve at the lower end of the wound. The junction of the left innominate, subclavian and jugular veins was seen. A finger was passed down behind the sternum alongside of the œsophageal wall. An attempt was

made to tilt the plate inwards so that it might be seen and removed through the œsophagoscope. This manœuvre failed. The œsophagus was then opened, the lower pointed end of the plate bearing a tooth was caught by a blunt hook and gently rotated upwards, after which it was removed without any difficulty through the wound. The chief fear lay in the possibility of tearing the œsophagus behind the sternum and producing a septic mediastinitis, a complication which almost invariably proves fatal.

A nasal tube was passed into the stomach through which the patient was fed for four days. At the end of a fortnight the wound was completely healed.

If the plate had been impacted further down in the œsophagus, resection of part of the sternum, ribs and clavicle would have become necessary for its exposure.

Such a case illustrates the role of the general surgeon in the removal of foreign bodies from the œsophagus and also the advantage of close co-operation between him and an assistant skilled in the use of the œsophagoscope.

Comment. It should be remembered that forcible manipulations in the extraction of a foreign body may lead to a fistula between the trachea and the œsophagus. A few minutes are well spent in loosening the foreign body from its bed before extraction is attempted. Free drainage of the wound and the passage of a nasal tube for feeding purposes minimise the danger of septic cellulitis. The nasal tube may be removed in three to four days and swallowing resumed. There is usually some transitory leakage.

In the case of coins or other obstructing bodies without jagged edges, the old much-abused coin catcher may be found useful if an œsophagoscope is not available. The writer has many times removed coins by this means. The operation, however, should be performed on the X-ray table. The coin catcher is introduced under the direct guidance of the fluorescent screen.

Foreign bodies near the cardiac end of the œsophagus may be pushed into the stomach by means of a bougie or tube. It may be necessary in some cases to open the stomach and remove them from the lower end of the œsophagus under direct vision.

DIVERTICULUM OF THE ŒSOPHAGUS

The so-called diverticula of the œsophagus are usually pharyngeal pouches which extend downwards into the neck. The first case recorded

of dilatation of the pharynx with diverticulum was by the writer's father. It is of historical interest. The operative findings and their anatomical significance are fully described. (Wheeler, *Trans. Roy. Acad. Medic., Ireland*, 1886, p. 131.) The pouches commence on the posterior lateral wall of the pharynx just above the junction with the œsophagus. The pouch is located behind and usually to the left of the œsophagus and resembles the finger of a glove. Pressure of the sac when filled causes obstruction to the descent of food down the œsophagus. Regurgitation is a usual symptom. It suggests stricture, but an X-ray examination after the administration of barium, or examination with the œsophagoscope, will readily reveal the true nature of the ailment. The sac may extend down the neck into the thorax.

Operation. The incision should be adequate. It extends from the cricoid cartilage in front of the sterno-mastoid to just above the clavicle on the left side. A transverse incision extending from the middle of the neck at the level of the cricoid cartilage to the middle of the left sterno-mastoid muscle is also recommended.

The œsophagus is exposed as already described. A bougie may be passed into the sac from above through the mouth in order to make the sac more prominent. The sac is carefully isolated by the division of adhesions between it and the wall of the œsophagus. This part of the operation should be painstakingly accomplished in order to obtain complete isolation of the sac. The next point is to free the neck of the sac until its junction with the œsophagus can be clearly demonstrated.

One of three procedures can now be adopted. (1) The sac when isolated may be fixed to the deeper structures of the neck so that the fundus is at a high level and food cannot any longer enter its cavity (fig. 998). (2) The sac may be so fixed that it protrudes through the neck and is subsequently removed (the two-stage operation). (3) The sac may be removed at a single-stage operation. Operations (1) and (2) are employed in order to avoid the danger of infection and the development of serious septic cellulitis or mediastinitis. With proper technique the single-stage operation is successful, and this alone will be described.

A silk thread with a shot attached is swallowed a few days before operation and is demonstrated by X-rays in the small intestine. An œsophagoscope with this thread as a guide is passed into the œsophagus beyond the diverticulum. The œsophagus is easily exposed, but the

diverticulum may not be so readily identified. If the œsophagoscope can be introduced into the sac the latter can be trans-illuminated by the light from the œsophagoscope, and the dissection commenced. The œsophagoscope is withdrawn from the diverticulum and passed again into the œsophagus, and the sac is further freed. Finally, the neck of the sac at its junction with the œsophagus is secured by fine tissue forceps and the whole sac removed with scissors.

The slit-like opening is now accurately closed with fine catgut and made watertight, the sutures being continuous. The second row

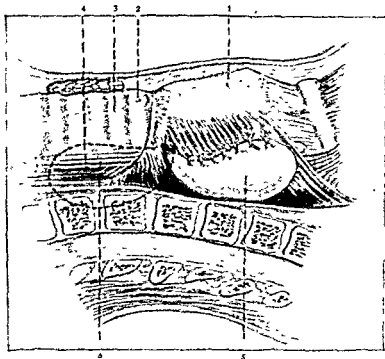


Fig. 998.—DIVERTICULUM OF THE OESOPHAGUS PHARYNGOPEXY. THE SAC HAS BEEN DISPLACED AND STITCHED IN AN UPWARD POSITION.

1 Thyroid cartilage. 2 Cricoid. 3 Trachea. 4, Oesophagus. 5 Pouch sutured to superior constrictor muscle. 6. Original position of pouch.

(From Carson's *Modern Operative Surgery*)

of sutures brings the muscular wall of the œsophagus over the sutured mucous membrane. The wound in the neck is closed layer by layer. A small rubber drain to the line of suture is left *in situ*.

Comment. The thread which the patient previously swallowed is divided and allowed to pass out per rectum. A nasal tube is passed into the stomach through which the patient is fed for a week. The drain is removed in 48 hours.

Throughout the operation aspiration can be employed through the œsophagoscope and the danger of any laryngeal contents escaping into the wound is thus minimised. If an œsophagoscope is not

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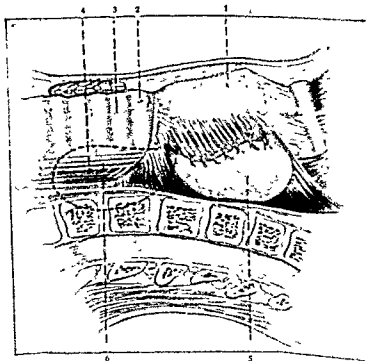


Fig. 898.--DIVERTICULUM OF THE ESOPHAGUS PHARYNGOSCOPY. THE SAC HAS BEEN DISPLACED AND STITCHED IN AN UPWARD POSITION.

1 Thyroid cartilage. 2 Cricoid. 3 Trachea. 4 Esophagus. 5 Pouch secured in upward position. 6 Original position of pouch.

(From Carson's *Modern Operative Surgery*.)

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available a bougie may be passed into the diverticulum, but great care must be taken as the walls of the sac are sometimes thin and friable.

THYROTOMY (LARYNGO-FISSURE)

This operation is sometimes employed for the fulguration or excision of limited growths in relationship to the vocal cords. Hoarseness lasting more than a month may be due to carcinoma. If the growth is detected early, conservative operations are justifiable. Excellent results follow operations for carcinoma of the larynx. In early circumscribed cases thyrotomy suffices; laryngectomy is

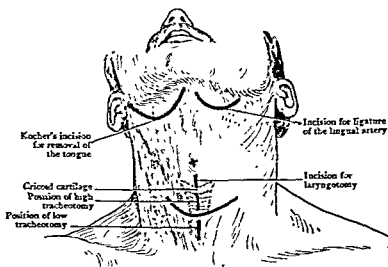


Fig. 992.—INCISIONS FOR SOME OF THE MORE COMMON OPERATIONS ON THE NECK.
(Wheeler's *Operative Surgery*.)

indicated when the disease is more advanced. In both cases the voice is retained in a satisfactory manner.

To perform the operation of thyrotomy with ease and safety a preliminary tracheotomy is recommended.

Steps of the Operation. The incision is made from the hyoid bone above to a level below the cricoid cartilage. It is made exactly in the middle line. The isthmus of the thyroid gland is exposed and divided. Tracheotomy by Digby's method is performed at this stage (see page 1912). Inhalation anæsthesia, if used, is induced through the tracheotomy tube, but as previously mentioned, colonic oil-ether anæsthesia will be found satisfactory. When the thyroid cartilage has been exposed a vertical incision is made through it in the middle line with curved

scissors, one blade being passed through an opening in the thyro-hyoid membrane. In elderly persons a small saw may be required. The division is made from above downwards. The incision is now carried upwards and downwards toward the hyoid bone and cricoid cartilage until good exposure is obtained. Hæmostasis and tranquil respiration are assisted by painting the mucous membrane with a 5 per cent cocaine and adrenalin solution. A small gauze swab with a long silk ligature attached to this swab is passed downwards towards the trachea above the tracheotomy tube. A similar swab may be passed upwards towards the pharynx. In this manner the operation area is isolated. A good headlight or small sterilisable electric lamp in the wound is of considerable assistance. A neoplasm can be removed by an incision round it through healthy mucous membrane. Fulguration will in many cases be the method of choice.

When all bleeding is controlled, the two segments of the thyroid cartilage are stitched together in accurate alignment. The divided thyro-hyoid and crico-hyoid membranes are sutured with catgut above and below. The tracheotomy tube is removed at the conclusion of the operation, but it should be kept at hand for re-introduction if urgently required.

The wound through which the tracheotomy tube was passed should not be closed.

Comment. When the growth is exposed after wide retraction of the alæ of the thyroid cartilage the muco-perichondrium and soft parts surrounding the growth are raised up with a periosteal elevator. The tumour, with a good margin of healthy tissue, is then excised with scissors. It is often necessary to remove the anterior end of a vocal cord and part of the arytenoid cartilage. If the latter is necessary, the inhalation of fluids may follow attempts to swallow. In all cases it is advisable to feed the patient through a nasal tube, which is left in position for 4 or 5 days. In over 90 per cent of cases of carcinoma of the larynx the patients are males.

LARYNGOTOMY

This operation is indicated as a preliminary to extensive operations on the tongue, tonsils, and upper portions of the pharynx. It is, perhaps, especially indicated in cases of suffocation from œdema of the glottis in adults. A cyanosed and almost asphyxiated patient can be relieved by laryngotomy more readily than by any other method.

With the head extended a transverse incision is carried across the middle line of the neck at the level of the upper border of the cricoid cartilage. An opening is made in the crico-thyroid membrane with the point of the knife or a pair of pointed scissors. The opening should be kept close to the upper border of the cricoid cartilage in order to avoid a small crico-thyroid artery which passes across the middle of the membrane. A laryngotomy tube, which differs from a tracheotomy tube in being oval on cross-section, is introduced and retained by tapes passed round the neck. The space between the cricoid and the thyroid cartilage is so small in children that the operation is unsuitable.

If bleeding occurs from the small transverse arteries, no time need be lost, as the introduction of the tube effectively stops the hæmorrhage.

Cases have been recorded when, in a great emergency, the blade of a pocket knife was plunged through the crico-thyroid membrane and the air-passage kept open by rotating the knife.

TRACHEOTOMY

As an emergency procedure, tracheotomy is indicated in the case of children for such conditions as diphtheria, scalds of the glottis, or the impaction of foreign bodies. In adults, as already mentioned, laryngotomy is the operation of choice under similar circumstances

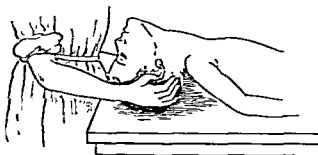


Fig. 1999.—TRACHEOTOMY. CORRECT POSITION OF HEAD PRIOR TO MAKING INCISION.

On the other hand, tracheotomy is indicated as a preliminary to extensive operations on the pharynx or larynx, or as a palliative measure to avoid asphyxiation in cases of inoperable malignant disease. Syphilis and tuberculosis of the larynx are occasional indications.

Tracheotomy can be admirably performed under local anæsthesia. It is merely necessary to infiltrate the superficial tissues in the middle line of the neck from the thyroid cartilage to above the supra-sternal notch. Chloroform is the anæsthetic of choice in young children.

Ether and gas are to be avoided in every case of real or potential asphyxia.

Operation. The head is extended in the usual manner by a sand-bag under the shoulders. The patient, especially if a small child, is brought well over to the edge of the table. An assistant holds the head in the extended position so that the chin and sternal notch are accurately in a straight line (fig. 1000). The cricoid cartilage is identified and an incision made from its upper border downwards: this should be about

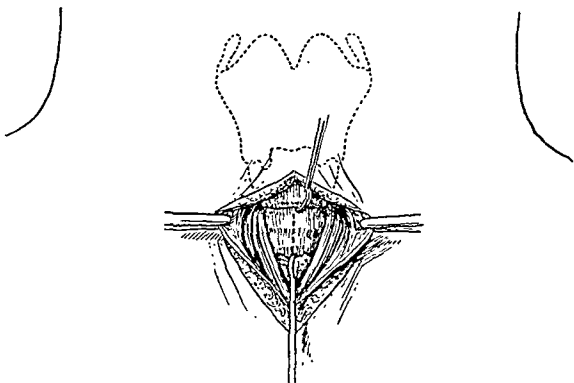


Fig. 1001.—TRACHEOTOMY. THE TRACHEA IS EXPOSED BY RETRACTION DOWNWARDS OF THE THYROID ISTHMUS. THE CRICOID IS STEADIED WITH A SHARP HOOK. (Diagrammatic.)

(Wheeler's Operative Surgery.)

2 inches in length. The anterior jugular veins are drawn aside or may be divided and ligatured. The deep fascia is divided transversely below the cricoid, and the inner margins of the sterno-hyoid and sterno-thyroid muscles are exposed and retracted. With a little blunt dissection, the trachea is exposed.

The isthmus of the thyroid gland bulges and gets in the way; it can be loosened with the nose of a pair of forceps passed between it and the trachea and retracted downwards with a blunt hook. At this stage the surgeon inserts a sharp hook beneath the cricoid cartilage in the middle line to steady the trachea and hold it forward. The hook is held in his left hand while the trachea is incised (fig. 1001).

Digby's method. It is often of advantage to divide the isthmus between two hæmostatic forceps, as the trachea is thus exposed at a lower level. These forceps steady and bring the trachea forward, rendering the hook in the cricoid unnecessary. The second, third and fourth rings of the trachea are divided and a portion of each ring may be snipped off from either side to enlarge the opening. This manœuvre avoids the difficulty of introducing the tracheotomy tube through a slit-like aperture. Stab openings are dangerous, as the point of the knife is out of control and may be plunged too deeply (fig. 1002).

In the classical descriptions, high tracheotomy is referred to when the trachea is opened above the isthmus, low tracheotomy when the opening is made between the isthmus and the supra-sternal notch.

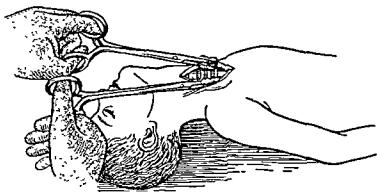


Fig. 1002.—TRACHEOTOMY: DIGBY'S METHOD. (Diagrammatic.)

If the isthmus is divided the surgeon is not embarrassed by such artificial divisions, and inexperienced operators will not be harassed by academic and "text-book" recollections when faced with a serious emergency.

Low tracheotomy is a difficult procedure in an adult; the trachea passes deeply into the neck as it descends. It is not so difficult in children, but, as already pointed out, the left innominate vein sometimes lies at a high level, and if engorged may be in danger during the operation.

Immediately the trachea is opened there is a forcible expulsion of blood-stained mucus. The coughing continues after the tube is introduced, but ceases in a few moments.

Low Tracheotomy. The incision extends from the cricoid cartilage to the supra-sternal notch accurately in the middle line of the neck.

The anterior jugular veins are caught in forceps and retracted. The deep cervical fascia is divided and the interval between the sterno-thyroid muscles is sought. The inferior thyroid veins descend in the fatty tissue in front of the trachea; they can usually be displaced by blunt dissection and the trachea exposed. The trachea is steadied by a sharp hook as in high tracheotomy and is divided from below upwards. A suitable tracheotomy tube director or the handle of the knife keeps the incision in the trachea open during the introduction of the tube, or a portion of two or three rings may be removed to enlarge the opening.

Comments. The sharp hook mentioned above should not be removed until the tracheotomy tube is inserted, otherwise the trachea retracts deeply and the opening in it is lost. In the meantime blood may be aspirated.

Care must be taken to control the knife; in young children the blade may pass too deeply and wound the œsophagus.

The tracheotomy tube should be removed on the third to the fifth day.

Occasionally secondary hæmorrhage occurs from ulceration of a large blood-vessel, caused by pressure of the tracheotomy tube. It can be avoided by the use of tubes of a suitable size and by not allowing them to remain in position for too long a period.

Tranquil Tracheotomy. (St. Clair Thomson's Method.) In cases where rapidity is not essential a few drops of 5 per cent cocaine solution are injected with a hypodermic syringe and needle between two rings of the trachea before the trachea is opened. In a few moments the cough reflex is abolished and the trachea can be opened without the usual paroxysm of expulsive effort. From personal experience the writer can recommend this simple procedure.

REMOVAL OF MALIGNANT GLANDS IN THE NECK

Position of Patient. The shoulders are raised by a sand-bag and the head is turned to the opposite side.

Various incisions have been recommended. A good exposure will be obtained by an incision from the mastoid process to the sterno-clavicular joint. This is joined by a second incision from the symphysis menti to a point just above the middle of the sterno-mastoid muscle. The skin, superficial fascia and platysma are divided and the tissues

in the flaps thus outlined are reflected. The cervical fascia of the anterior triangle is thus widely exposed (see fig. 988). The sterno-mastoid muscle is defined along its anterior border and is retracted backwards. The cervical fascia and the underlying cellular tissue with the lymph glands are dissected from below upwards in the form of a flap. This dissection exposes the great vessels and their sheath. The glands in relationship to the internal jugular vein are carefully peeled upwards with those in the more superficial tissues. Tributaries of the internal jugular vein require division and ligature when mobilising the glands.

The sterno-hyoid, sterno-thyroid and omo-hyoid muscles are cleaned and all loose fatty tissue removed. During the course of the dissection the external jugular vein is preserved, if possible, together with the great auricular nerve. When the upper regions of the neck are reached, the submaxillary triangle is cleaned and the submaxillary salivary gland is removed together with the lymph glands in its neighbourhood. The dissection is now carried forward to the submental region and a lymph gland is removed from between the genio-hyoid muscles. Two or three glands will then be found above the hyoid bone between the anterior bellies of the digastric. Some care must be taken to expose the spinal accessory nerve which will be found in the upper and posterior part of the dissection running downwards and backwards to enter the deep surface of the sterno-mastoid muscle. The lower portion of the parotid gland will be exposed and may require excision in order to remove completely the parotid group of lymph glands. This procedure is followed after operation by the escape of saliva, but a permanent salivary fistula does not result.

In the earlier part of the dissection while removing the glands in relationship to the internal jugular vein, the latter may be torn or injured. Pressure with a swab for a few seconds controls the bleeding. A lateral ligature may be applied to the rent. On the other hand, the glands may be so adherent to the internal jugular vein that it (the vein) must be ligatured as low down as possible in the neck, and removed with the glands from below upwards. When both sides of the neck are involved, the complete dissection should be undertaken on the opposite side after an interval of about ten days. If the internal jugular vein is sacrificed on one side great care should be taken to spare it on the other.

As mentioned elsewhere, the more recent developments in radio-therapy should be carefully considered before the operation is undertaken.

CYSTIC TUMOURS OF THE NECK

Dermoid cysts, sebaceous cysts, and bursal cysts require no special description when they arise in the neck.

With the exception of thyroglossal cysts and enlargements of the subhyoid bursa, most of the cystic conditions in the neck remain stationary during the act of deglutition.

Hydrocele of the Neck, or cystic hygroma, may be unilocular or multilocular, congenital or acquired.

The cyst is a lymphangioma arising under the deep fascia and projecting in front of or behind the sterno-mastoid muscle. It may extend deeply into the tissues and reach the mediastinum, sending tentacles between the various muscles.

It is usually located at the root of the neck and is translucent.

Operation. This entails a deep dissection amongst the structures at the root of the neck. If during the operation for removal the procedure is attended with unsuspected difficulties, the edges of the cyst may be sutured to the skin and the cavity packed with gauze. After several weeks and repeated changing of the gauze packing obliteration results. In young children operation should be avoided. In the unilocular variety the injection of sclerosing solutions such as quinine and urethane is sometimes successful in obliterating the sac.

Blood Cysts. These may be in connection with a cavernous angioma or a diverticulum in the wall of a large vein. They have an impulse on coughing and a venous thrill. Hæmorrhage into a cystic adenoma of the thyroid or a branchial cyst must be borne in mind. Excision is not attended with any great difficulty if an adequate exposure of the surrounding structures is first made.

Branchial Cysts. These arise by the distension with fluid of an unobliterated portion of a branchial cleft.

They are usually found in connection with the third cleft in relationship with the upper third of the anterior border of the sterno-mastoid muscle at the level of the thyroid cartilage or hyoid bone. Cysts in connection with the second branchial cleft are found just below the mastoid process. They extend towards the floor of the mouth.

Branchial cysts are not adherent to surrounding structures, but are often mistaken for breaking-down tuberculous glands.

On aspiration the contents of the cyst resemble tuberculous pus, and cases are recorded in which the contents contained tubercle bacilli.

Like so many other congenital conditions these cysts make their appearance in adult life. When the diagnosis is in doubt, a little of the fluid is aspirated with a hypodermic needle and syringe, and a drop is placed on a slide and examined with a high power microscope. Cholesterol crystals are found in abundance.

Operation. The removal of these cysts is not attended with difficulty, and they are easily isolated from the surrounding tissues. The operation should not be delayed too long, as a squamous-celled carcinoma arises very occasionally in connection with branchial clefts. Simple cysts

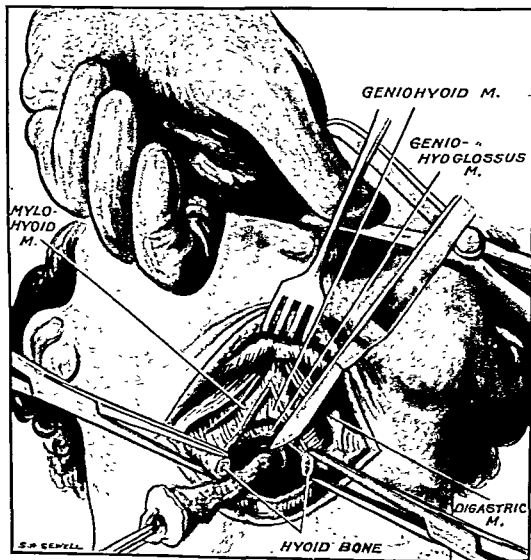


Fig 1003.—REMOVAL OF THYROGLOSSAL SINUS. (After Mayo-Cline.)

are more common in women, in relationship with the third cleft; when malignant changes occur, they are more frequently seen in men in connection with the second cleft.

CYSTS AND SINUSES OF THE THYROGLOSSAL DUCT

In foetal life the thyroid gland is formed at the base of the tongue and gradually descends to occupy a position in the middle line of the neck. The passage produced by the descent is normally obliterated. If any of it remains, secretion has an exit through the foramen cæcum

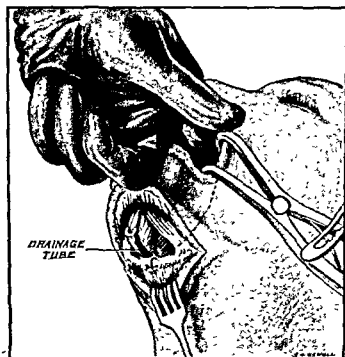


Fig. 1004.—REMOVAL OF THYROGLOSSAL SINUS. (After Mayo Clinic.)

into the mouth. If there is no exit, the secretion tracks downwards and produces a cystic tumour in the median line of the neck between the hyoid bone and the thyroid cartilage. Such cysts may be found as low as the sternal notch. Branchial cysts, on the other hand, always lie external to the mid-line. An enlarged subhyoid bursa resembles a thyroglossal cyst. Both move upwards during the act of swallowing. On section the former is lined with endothelium, the latter with epithelium.

Operation. The cyst is exposed by a transverse incision. The dividing line between the sterno-hyoid muscles is defined and divided vertically, and the cyst is dissected free to the level of the hyoid bone. The communicating sinus may pass superficially or deeply to the hyoid bone, or

even through it. To expose the sinus freely it is advisable to remove a small portion of the hyoid bone in the middle line. The mouth is opened with a gag and the tongue pulled forwards. An assistant's finger in the mouth arched over the back of the tongue pushes the latter forwards and brings the foramen cæcum and any remaining portion of the tract within reach of the operator (fig. 1003). The duct is so small that it cannot be dissected out alone, and some of the tissues through which it passes must be sacrificed. The tissues removed include portions of the mylo-hyoid, genio-hyoid and genio-glossus muscles. The wound is closed by deep sutures, and the divided edges of the hyoid bone are approximated and stitched into position. A small piece of rubber tissue passing deeply into the muscles of the tongue is employed as a drain (fig. 1004).

LARYNGOCELE

E. H. Bennett of Dublin was the first to discover (1865) a human larynx in which there existed fully-formed laryngeal pouches which are normally found in a high state of development in some of the apes. Bennett was dissecting in the region of the thyroid cartilage. His attention was arrested by a cystic structure which he opened accidentally

on one side. A probe was passed downwards through the opening into the larynx, and a similar sac was found on the opposite side. The pouch occupied a space which is covered by the thin lateral portion of the thyro-hyoid membrane. The lower portion of the protrusion rested on the superior laryngeal vessels and nerve. The upper border was in contact with the great cornu of the hyoid bone.

The illustration (fig. 1005) shows a patient suffering from laryngocele. In this case the laryngeal sac on the right side had extended through the thyro-hyoid membrane in an upward direction behind the

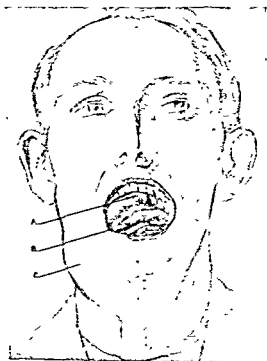


Fig. 1005.—LARYNGOCELE. A. LINGUAL SWELLING. B. DEVIATION OF TONGUE. C. SCHEMATIC SWELLING.
(Wheeler, Surg., Gyn., and Obstet.)

body of the hyoid bone, to the floor of the glossoepiglottic fossa. (Murphy Oration, *Surg., Gynec., and Obstet.*, Vol. lvi, 274.)

The patient was a man aged 24 years, who suffered all his life from a painless bulge or swelling in the right submaxillary region. This swelling was tympanitic and disappeared under pressure. The swelling moved and protruded with deglutition or coughing. The right side of the tongue and floor of the mouth were enlarged. On the posterior third of the dorsum of the tongue on the right side there was a soft conical projection about the size of a lump of sugar. The tongue could not be protruded (fig. 1005).



Fig. 1006.—LARYNGOCELE. X-RAY OF SUBMAXILLARY SWELLING AFTER INJECTION OF LIPIODOL INTO LINGUAL PROJECTION. (A.P. VIEW.) NOTE THE TRICKLE TOWARDS THE LARYNX.

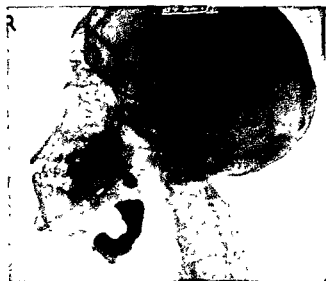


Fig. 1007.—LARYNGOCELE. X-RAY SHOWING LINGUAL AND SUBMAXILLARY SWELLINGS CONNECTED BY A VERY NARROW CHANNEL. (LATERAL VIEW.)

Any attempt to do so resulted in deviation of the entire organ to the right side. Speaking was difficult. It was owing to the fact that his friends could not understand what he said that he came to hospital to seek advice. The swelling on the tongue and the swelling in the submaxillary region were connected. If the one was pressed upon, the other enlarged. It was obvious that the swellings were

not solid, nor did they contain fluid. The introduction of a hypodermic needle into the protrusion on the tongue gave no information. Injection of lipiodol through the needle followed by X-ray photographs confirmed the observation that the tongue swelling and the submaxillary swelling were connected. The fact that lipiodol did not enter the larynx in the case under review may be explained on the hypothesis that the opening was either very minute or of a valvular nature (figs. 1006 and 1007).

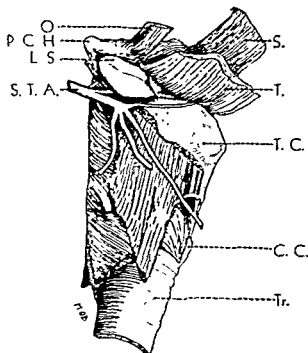


Fig. 1008.—LARYNGOCELE. (Drawing from specimen in Medical School, Trinity College, Dublin.)

O. Omo-hyoid.	S. Sterno-hyoid.
P.C.H. Hyoid bone.	T. Sterno-thyroid.
L.S. Laryngeal sac.	T.C. Thyroid cartilage.
S.T.A. Superior thyroid artery.	C.C. Cricoid cartilage.
	Tr. Trachea.

At this stage, the true condition was not realised. The patient died suddenly during the induction of anaesthesia.

The appendix of the laryngeal ventricle on the right side had extended through the thyro-hyoid membrane in an upward direction behind the body of the hyoid bone to the floor of the glosso-epiglottic fossa.

There is no mention in surgical literature of the extension of these congenital laryngeal pouches into the tongue. In the apes they extend

down the neck, often as far as the clavicle or between the two heads of the great pectoral muscle into the axilla. They attain a very large size.

von Bergmann mentions laryngocele and congenital air cysts in connection with swellings of the neck. He and other German writers refer to the danger of sudden death from suffocation when the sac becomes over-distended.

Comments. In his treatise on *Anatomy*, Quain states that the blind end of the appendix sometimes passes upwards, lateral to the aryepiglottic fold and behind the body of the hyoid bone, so as to lie close to the floor of the glosso-epiglottic fossa. In this volume reference is made to Sclavunas, who collected reports of 10 cases of congenital laryngocele. Two were bilateral, 4 were unilateral, and 4 were bilateral but with a larger sac on one side.

André Forster, professor of medicine in Strasbourg, gives a very fully illustrated account of the laryngeal sac in apes.

SOLID TUMOURS OF THE NECK

Apart from swellings in connection with the blood-vessels, the lymphatic glands and the thyroid which are mentioned elsewhere, there are but few primary tumours of the neck which require consideration. Of the non-malignant growths lipomata are by far the most common. Mixed tumours (myxochondro-endotheliomata) arise in connection with the salivary glands and sometimes independently of these, possibly from the branchial clefts.

Squamous-celled epithelioma arises definitely from the branchial clefts, but is rarely encountered.

Lympho-sarcoma is a common form of malignant growth in the neck, and arises primarily in the lymphatic glands or from a primary growth in the tonsil.

Few of the cases are operable. There is a rapid spread and the surrounding structures become infiltrated at an early stage. Other forms of sarcoma are also found, including the fibro-sarcomata, which grow less rapidly and infiltrate less deeply than those arising from the lymphatic glands.

Tumours of the carotid body require special mention.

The carotid body lies at the bifurcation of the common carotid artery. From it spring innocent tumours of the endothelial type. In the early stages they remain innocent, but later they undergo malignant

change. Local recurrence is so common that radical operation is always indicated.

Diagnosis is difficult, but the following points are helpful (Royster) :

- (1) Location at the bifurcation of the common carotid.
- (2) Lateral mobility.
- (3) Ovoid form and a firm elastic consistency.
- (4) Expansile pulsation and systolic bruit.
- (5) Anterior arching of the wall of the pharynx and paralysis of a vocal cord.
- (6) Occasional narrowing of the pupil on the diseased side.
- (7) No pain and slow growth.

Carotid tumours may be mistaken for aneurysm or aberrant thyroid, or for many of the swellings in the neck already mentioned.

The removal of a tumour of the carotid body entails ligation of the common carotid artery together with the internal and external vessels. All three arteries are divided and portions of the vessels removed with the growth.

Halsted advised the preliminary ligation of the common carotid and the extirpation of the growth after an interval of several days. Radio-therapy has not been successful in this type of tumour.

Some cases are mentioned in which not only the large arteries required removal, but also the internal jugular vein, the vagus nerve and the sympathetic trunk. These extensive procedures entail considerable risk.

A very guarded prognosis should be given until the conditions found by operation have been ascertained.

CUT-THROAT

Suicidal attempts are often futile as only the superficial tissues are severed. In such a case the margins of the wound are excised together with any ragged tissues, the raw surfaces are sponged with methylated spirit, and a very thin layer of B.I.P.P. is smeared over all the exposed area, after the method of Rutherford Morison. The muscles are stitched together and closure is completed without drainage. More extensive wounds high up in the neck may open into the pharynx, and partially divide the epiglottis.

Treatment of Serious Injury. Hæmorrhage is controlled, the epiglottis is sutured if necessary, the mucous membrane of the pharynx is identified and stitched with fine catgut. The remainder of the wound is treated as in the case of superficial wounds, but drainage is employed.

In wounds lower down involving the larynx, the method of treatment is the same. All divided structures are united by catgut. If there is respiratory embarrassment, laryngotomy should be performed. When the thyroid cartilage is divided transversely, two or three mattress sutures are introduced for its repair. Sometimes the trachea is partially or completely divided. In this case a wide exposure of the wound should be made in the manner described under tracheotomy. In cases of complete division the lower segment of trachea retracts downwards. A tracheotomy tube is inserted into the existing wound, or this may be sutured, and the tube introduced into the trachea at a lower level.

If a suction apparatus is at hand, it is a useful implement to remove blood and mucous collections from the wound and respiratory tract. By its means the great danger of broncho-pneumonia and suppuration may be minimised.

Comments. It is remarkable the amount of injury which can be inflicted without fatal results in the interval between the thyroid and the hyoid bone—the common site for suicidal wounds. The posterior wall of the pharynx and the pre-vertebral muscles may be gashed without any serious hæmorrhage. The carotid artery and internal jugular veins are mobile and very often escape injury.

THE THYROID GLAND

About nine-tenths of the simple goitres which are referred for surgical treatment are adenomatous. Toxic adenoma (Plummer's disease) or primary toxic goitre (Graves' disease) require operative treatment as a rule, but in certain selected cases of Graves' disease conservative methods suffice. It should be clearly realised by physicians and those commencing to learn the art of surgery, that the operation of thyroidectomy performed by modern methods is as bloodless as other operations, and that when adequate pre-operative precautions have been taken, the mortality is less than 1 per cent. The possibility of a retro-sternal goitre (simple or toxic) should always be remembered. It may exist without enlargement of the thyroid gland in the neck, but it can be demonstrated by X-rays. Early malignant

changes in a goitre cannot be recognised by clinical methods. When the disease is advanced, operative treatment is of little avail. Early metastases are common in the lymphatics, lungs, bones and brain.

Fixed and easily recognisable malignant growths should be treated by radio-therapy. Eighty to ninety per cent of such goitres commence in pre-existing adenomata. All adenomatous goitres should be removed owing to the danger of malignancy or toxicity. If they are found to be malignant histologically, post-operative radiation should be employed.

Plummer and others state that auricular fibrillation contra-indicates the use of digitalis in cases of toxic adenomatous thyroids. They believe that the operative mortality dropped from 3.5 per cent to approximately 1 per cent by stopping the use of digitalis in these cases.

True exophthalmic goitre may occur in children, and early recognition of symptoms is important. The patients are often under 10 years of age. The signs and symptoms do not vary from those seen in the adult. There is the exophthalmos, the tachycardia, the tremors, loss of weight, and other well-known symptoms. In both children and adults the three most striking signs of true hyperthyroidism are the ocular stare which precedes exophthalmos, the constant movements of the hands, and muscular weakness, easily demonstrated in the case of the quadriceps femoris muscles. The patient is asked to step up on a high stool, but finds the greatest difficulty in doing so. The increased appetite associated with loss of weight is also characteristic. There are the same indications for operation in children as in adults. In children myxœdema is more likely to follow operation, and the removal of thyroid tissue should not be too radical.

In the Mayo Clinic there has been an intensive study of hyperthyroidism and its complications. It is pointed out *inter alia* that toxic goitre, both exophthalmic and adenomatous, may be present during pregnancy. In making the diagnosis it must be remembered that there is a rapid increase in the basal metabolic rate during the last three months of normal pregnancy which is not due to abnormal thyroid secretion. Pregnancy in all probability has no influence on the course of exophthalmic goitre. The presence of one condition does not apparently influence the other. Lugol's solution is employed in the usual manner and may suffice to control the hyperthyroid condition until after the pregnancy, or the solution may be administered as a preliminary to thyroidectomy.

The surgeon is sometimes asked for an opinion in cases of hyperthyroidism associated with the presence of sugar in the urine. It has been pointed out in the Mayo Clinic that symptoms of hyperthyroidism

in a patient with diabetes may be obscured by those due to the diabetes, especially in the presence of severe acidosis or diabetic coma. The possibility of hyperthyroidism should be considered in all cases of diabetic acidosis. The necessity for insulin is increased by hyperthyroidism, and Lugol's solution should be administered in larger quantities; up to 60 minims daily may be required. Thyroidectomy is not contra-indicated in these cases, on the contrary there is a marked improvement in the diabetic condition when the gland is removed. In the post-operative period there is a danger of hypoglycæmia, and patients are peculiarly sensitive to overdoses of insulin. It is noteworthy also that in cases of hypoglycæmic coma there is a striking rise in the blood-pressure.

ACUTE INFLAMMATION OF THE THYROID GLAND

This condition may arise in a previously normal thyroid or pre-existing goitre. The inflammation not infrequently resolves but, on the other hand, suppuration may follow. Respiratory embarrassment is the indication for immediate operation.

A collar incision such as is employed in thyroidectomy is made over the swelling. The pre-tracheal muscles are divided and the whole area is in this way decompressed. Rubber tissue drainage is employed when pus is found. If an inflamed pre-existing goitre is present it can, as a rule, be removed with safety. Occasionally the sudden swelling and respiratory embarrassment may be due to a hæmorrhage into an adenomatous cyst. Aspiration of the cyst may suffice, but, if this is ineffectual, operation for the removal of the cyst must be undertaken promptly. Such operations avoid the necessity of tracheotomy, which would be attended with great difficulty in this type of case. The writer has recorded a case in which the hæmorrhage extended beyond the thyroid cyst infiltrating all the deeper tissues of the neck with a fatal result.

REIDEL'S CHRONIC THYROIDITIS

This condition was described by Reidel in 1896.

A stony hard tumour appears in one or both lobes of the thyroid gland. The swelling may be diffuse or localised. It frequently becomes adherent to or infiltrates into the adjacent structures.

Pain is absent, but as time advances pressure symptoms become

urgent. The condition has frequently been mistaken for carcinoma, but microscopically there is no evidence of malignancy.

Operative removal is indicated. The operation may be simple or extremely difficult according to the presence or absence of adhesions and infiltration.

Partial or piecemeal removal of the gland in difficult cases often will relieve pressure symptoms. Emergency procedures such as tracheotomy are to be avoided.

The disease is rare. Bernard Shaw and R. P. Smith of Newcastle-on-Tyne could only find 23 cases in the literature (1896-1924). The ætiology is unknown. The condition is not associated with syphilis or tuberculosis. A slow chronic inflammatory process of a granulomatous nature terminating in complete fibrosis attacks the gland without known cause. Shaw and Smith (*Brit. Jr. Surg.*, Vol. 13, p. 100) give a summary of six cases as follows :

- (1) All females, between the ages of 32 and 58.
- (2) Three cases were early, the disease being confined to the interior of the gland.
- (3) Three cases were relatively advanced, the process having spread outside the thyroid, but not sufficiently far to prevent removal. Compression symptoms present in all.
- (4) In four out of five cases the clinical diagnosis was malignant disease.
- (5) Two cases with local enlargement were cured by removal, which was done without difficulty. In one case partial removal did not cure. Total thyroidectomy cured two cases with general enlargement.

PRELIMINARY LIGATURE IN GRAVES' DISEASE

There is considerable difference of opinion with regard to preliminary ligation as a first step towards thyroidectomy in severe cases of toxic goitre. The writer's views were expressed as follows in a letter to the *B.M.J.*, September 21, 1934 :

"About twelve years ago the pre-operative treatment of Graves' disease was placed upon a firm scientific basis. Since that time the indications for preliminary arterial ligation are few and far between.

It is true, but not universally true, that the patients who derive greatest benefit from ligation belong to precisely the same group as those who respond readily to the administration of iodine. Conversely, if iodine fails it is reasonable to assume that

ligation will prove a disappointment. Dogmatism is, however, to be avoided in this as in most other surgical considerations.

After a long experience in an area in which Graves' disease was not uncommon, I have been guided by certain beliefs.

(1) In the case of the really bad surgical risk in which adequate and prolonged pre-operative preparation is of no avail, ligation is indicated. The second or third shot sometimes hits the target and the prognosis may become completely changed. Thus ligations, although rarely indicated, may convert a bad surgical risk into a case safe for thyroidectomy when other weapons have failed.

(2) A severe reaction sometimes follows ligation or any other procedure. Such a reaction indicates the intolerant condition of the patient, and is a warning to proceed with caution by carefully graded operative measures.

(3) In the event of a fatal result following ligation in the serious type of case under review surgery is blameless.

(4) It is important to ligate the trunk of the superior thyroid artery after clear exposure. The anterior branch is sometimes mistaken for the main vessel. Additional ligature of both anterior and posterior branches inhibits the collateral circulation from below. Personally I avoid thyroidectomy in a case of uncontrolled hyperthyroidism without a preliminary attempt to obtain control by ligations. We must recognise, however, that the personal factor is of importance.

Each surgeon will obtain the best results by following the path with which he is most familiar, but familiarity with thyroidectomy does not necessarily imply familiarity with the ligature of the isolated thyroid trunk. I have seen Kocher, Mayo, Crile, and many others at home and abroad, including some of your correspondents, operate on cases of severe hyperthyroidism. As a spectator one felt instinctively that if each had operated in precisely the same manner the brilliancy of the results would have been adversely affected.

Preliminary ligation of the inferior vessels, sometimes recommended as a step towards thyroidectomy, is attended by too much disturbance to justify it as a routine. Here again personal factors must be weighed. Some surgeons have perfected their methods of approach and regard ligature of the inferior thyroid artery as a valuable addition to the patient's defence. Finally, may I suggest the retention of the term 'Graves' disease' in general discussions on this subject? Knowledge is incomplete until the works of the great Dublin physician are studied and digested."

THYROIDECTOMY

The writer has seen many different methods of operating in the Mayo Clinic, in Crile's Clinic, in Kocher's Clinic, and in the clinics at home. The method he personally has found convenient and safe will be described, but each surgeon, as experience extends, develops his own technique.

The thyroid gland is surrounded by a definite fibrous capsule, derived from the deep cervical fascia. This capsule must be divided in order to mobilise the gland. The parathyroid glandular bodies are

best preserved by pushing this capsule backwards by blunt dissection, when isolating the posterior aspect of the goitre. The superior thyroid arteries and veins are easily secured as they enter the upper poles of the lateral lobes of the gland. The inferior thyroid artery passes behind the common carotid artery to reach the deep aspect of the lateral lobe well above the inferior pole. When the goitre is dislocated a little blunt dissection exposes the site of the common carotid artery, and the inferior thyroid may often with advantage be ligatured in this situation. It can be felt pulsating as it passes inwards in the direction of the trachea. The close relationship of the recurrent laryngeal nerve to the artery must always be borne in mind.

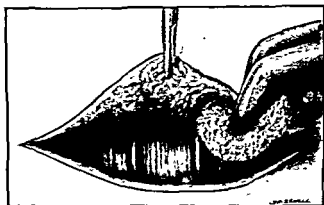


Fig 1009.—THYROIDECTOMY. AFTER DIVISION OF THE SUPERFICIAL STRUCTURES THEY ARE DISSECTED AND WIPED UPWARDS AND DOWNWARDS TO GIVE MORE ROOM. THE PRE-TRACHEAL MUSCLES AND ANTERIOR JUGULAR VEINS ARE SHOWN.

Lateral thyroid veins pass from the gland outwards to the internal jugular vein. These must be divided and ligatured in order to obtain the proper line of cleavage when mobilising the goitre. After dislocation of the thyroid lobe the recurrent laryngeal nerve may be drawn forwards into close relationship with the side of the trachea.

Anæsthesia. Notwithstanding authoritative advocacy in favour of basal narcotics, rectal oil-ether anæsthesia in combination with local infiltration is preferred by the writer. Local anæsthesia alone, with a preliminary injection of morphia ($\frac{1}{8}$ gr.) and atropine ($\frac{1}{100}$ gr.) or omnopon and scopolamine, suffices if general anæsthesia is for any reason contra-indicated. Continuous gas and oxygen is recommended as an alternative to colonic oil-ether. It has the advantage of allowing phonation at intervals and thus ascertaining if the recurrent laryngeal nerves are in danger.

Operation. The head of the table is slightly raised and a sand-bag is placed behind the shoulder so as to render the goitre prominent. The writer's face-screen or any other frame to isolate the head and face is put in position, the skin is prepared, and the sheets arranged as previously described (see page 1890).

10-20 cc. of $\frac{1}{2}$ per cent novocaine solution, containing a few drops of adrenalin, are injected under the skin in the line of the intended incision. Half this amount is then injected deeply into the region of the upper poles; a similar injection is made deeply towards

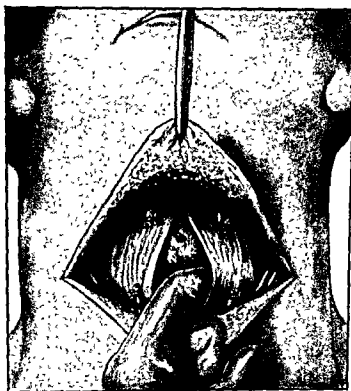


Fig. 1010.—THYROIDECTOMY. THE MUSCLES ARE RAISED WITH THE FINGER FROM THE UNDERLYING CAPSULE OF THE GLAND.

the inner end of the clavicle. The adrenalin is omitted in cases of toxic goitre. (There is some difference of opinion regarding the contra-indication for adrenalin. It is safer, therefore, to omit it.)

A few scratches of a needle are made on the skin prior to the incision to facilitate accurate suture at the end of operation. The skin and superficial fascia are divided over the most prominent portion of the goitre in a transverse direction. The incision extends in most cases from the middle of one sterno-mastoid muscle to a corresponding point on the opposite side. The platysma is not divided. The skin and superficial fascia are dissected upwards towards the chin and by means of gauze swabs can be pushed still farther in this direction.

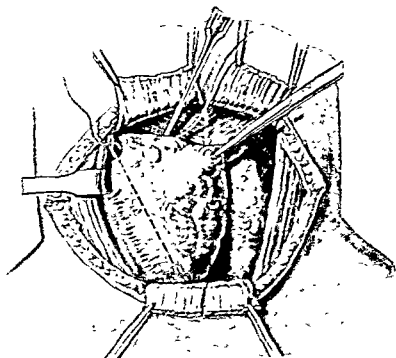


Fig. 1011.—THYROIDECTOMY.—THE GOITRE HAS BEEN FREED. A LIGATURE IS PASSED AROUND THE SUPERIOR THYROID ARTERY. THE DOTTED LINE SHOWS THE LINE OF DIVISION. (*After Lacey*)

The lower skin edge is treated in a similar manner. The platysma is divided vertically, exactly in the middle line of the neck for as great a length as the exposure permits. The deep cervical fascia covering the pre-tracheal muscles comes into view. This is similarly divided vertically in the mid-line. The anterior jugular veins are divided and ligatured when necessary. The sterno-hyoid and sterno-thyroid muscles are found stretched over the projecting goitre on either side. The mid-line interval between them is identified and they are widely separated. In difficult cases the platysma and the pre-tracheal muscles require a transverse division. It is advisable that the latter should be divided at a high level so that the nerve supply may be preserved. (It is not necessary to divide the muscles between forceps as only one or two vessels will be encountered.) A finger passed under these muscles isolates them from the thyroid capsule (fig. 1010). The capsule covering the goitre is now exposed. A small opening is made into an avascular portion in the proximity of one of the upper poles. The finger is passed through the opening, and the upper pole of the gland into which the superior thyroid vessels pass is defined. The capsule is now more freely opened and the finger is passed down the outer border of the gland. Its progress is impeded by the lateral thyroid veins. These are divided and ligatured.

The lobe is now free and can be dislocated forwards into the wound (fig. 1011). There may be some respiratory embarrassment for a few moments during the dislocation of the lobe. The posterior part of the thyroid capsule and connective tissues are displaced backwards with a swab. A blunt dissector, forceps, or aneurysm needle is passed under the superior pole, which should be well exposed (fig. 1011).

Three forceps are applied to this pedicle. It is divided between the upper two and the lower forceps. A ligature of strong catgut is placed above the uppermost forceps and tied. This forceps is then removed. The second forceps is held up and a second ligature applied. Two ligatures are used thus in order to prevent the possibility of the escape and retraction upwards of the superior thyroid artery. The goitre is now held by the assistant well over to the opposite side and the inferior thyroid artery is ligatured either as it passes from behind the common carotid or at its entrance into the posterior portion of the gland.

The isthmus should always be removed, but complete removal of the thyroid gland is to be avoided. A small portion in the region of the inferior thyroid artery and covering over the recurrent laryngeal nerve is left behind. To accomplish this three or four artery forceps are thrust into the substance of the gland and the latter is divided in front of them. These forceps secure the branches of the inferior thyroid artery (fig. 1012). Deliberate ligature of the artery is often by this means rendered unnecessary. The lower extremity of the goitre is mobilised

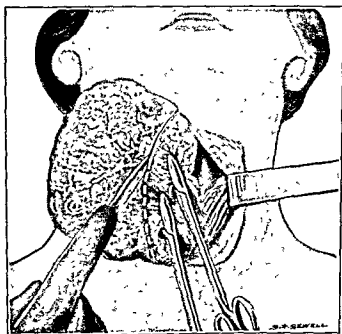


Fig. 1012.—THYROIDECTOMY. TWO ARTERY FORCEPS ARE IN POSITION. THE GOITRE IS BEING REMOVED BY WEDGE SHAPED INCISION.

with the finger. A cord of loose cellular tissue and inferior thyroid veins will be seen and require ligature and division. The thyroid lobe is now carried further across the trachea. The isthmus is gently separated and if one lobe only is to be removed, it is clamped and divided. If both lobes require removal, as in toxic goitre, the dissection is carried to the other side and both lobes, with the isthmus, may be excised *en bloc*, leaving a small portion covering the area in the region of the inferior thyroid artery, parathyroids, and recurrent laryngeal nerves. If the division of the thyroid tissue is made in a wedge-shaped fashion the margins

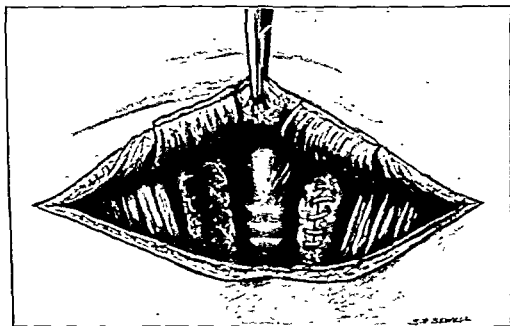


Fig. 1012.—THYROIDECTOMY. THE OPERATION ALMOST COMPLETED. ON THE LEFT THE SUTURES HAVE NOT BEEN INSERTED. THE PRE-TRACHEAL MUSCLES ARE DIVIDED BUT NOT YET SUTURED.

of the portion left behind can be brought together by sutures. In this manner oozing is stopped and the raw surfaces of the stump become neatly approximated (fig. 1013).

The wound is rendered quite dry by the ligature of some small vessels in front of the trachea. The finest possible catgut should be used. If drainage is thought advisable, a small stab wound is made in the lower skin flap and pieces of rubber tissue are passed on one or both sides of the trachea. If muscles have been divided they are sutured, special attention being paid to the divided platysma. The skin wound is closed by Michel clips, which may be removed after forty-eight hours. A gauze dressing and a few strips of elastoplast bandage complete the operation.

The patient may be allowed up on the second or third day.

It has been mentioned that individual operators remove goitres by different methods. Many favour division of the isthmus and dissection of the goitre from the trachea outwards. During the excision Crile injects local anæsthesia freely into the substance of the gland and into all the surrounding tissues.

CRILE'S OPERATION

Crile's technique is as follows :

(1) The operation is performed in the patient's room under light gas and oxygen anæsthesia supplemented by novocaine infiltration.

(2) The usual collar incision through the skin.

(3) The skin flaps are reflected leaving the undivided platysma behind. This muscle with the underlying sterno-hyoid and sterno-thyroid is divided by a long vertical incision in the anterior mid-line.

Crile believes that the most common cause of abductor paralysis of the vocal cords is the pull on the nerve which may occur when rolling out the goitre. The pull may cause partial and temporary or complete and permanent paralysis.

(4) If both lobes are of the same size and set deeply behind in the lateral aspect of the neck, the mode of attack is by vertical division of the gland in the mid-line, the division being carried to a point just short of the rings of the trachea and the laryngeal box. Then, with accurate hæmostasis, the attachments of the goitre to the trachea and larynx are caught and divided point by point. The division includes the attachments of both the upper and lower poles. After one lobe is raised the vessels are tied off. If the goitre is retro-laryngeal, it will slide out if the attachments to the larynx in front are divided. If the goitre is retro-sternal, the process of delivery "resembles the laying of an egg." It matters little into what recess the goitre is thrust once its attachment to the larynx has been divided.

Comment. It is pointed out by some that as the sterno-hyoid muscle has a much higher insertion than the sterno-thyroid, retraction of the former without division gives adequate exposure. The sterno-thyroid, on the other hand, needs division in difficult cases.

RETRO-STERNAL GOITRES

Pressure on the trachea often draws attention to the presence of these growths. They may be of considerable size and reach below the level of the aortic arch. Sometimes when the patient bends his head towards the shoulder on the affected side, the trachea is compressed and dyspnoea results. Bending it to the other side causes no distress.



Fig 1014.—RETRO-STERNAL GOITRE. DILATATION OF SUPERFICIAL VEINS (EXAGGERATED IN DRAWING) IN A CASE OF RETRO-STERNAL GOITRE.

Some complain that they are threatened with suffocation when asleep at night, but the final diagnosis is made by the X-ray shadow within the thorax. An X-ray photograph should be taken in every case of goitre or suspected goitre.

Occasionally the X-ray shadow will be found absent unless special radiographic technique is employed. A change in the outline of the trachea may be noticed; this is suggestive of growth. In short-necked individuals, the thyroid gland is at a lower level; adenomata

in the lower poles become sub-sternal. In such cases the entire thyroid may be displaced downwards into the thoracic inlet.

Plummer has pointed out that in retro-sternal goitres there is a change in the inspiratory sound to be detected with the stethoscope. It may be compared to a very slight stridor. The sound is only a slight exaggeration of the normal and may be termed "hollow."

Dilatation of the superficial thoracic veins on the chest wall is common in the retro-sternal goitres. The dilatation of these veins

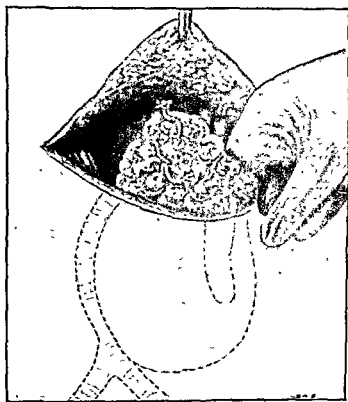


Fig. 1015.—RETRO-STERNAL GOITRE. METHOD OF APPROACH.

results from pressure on both internal jugular veins (fig. 1014). The writer has seen cases of intra-thoracic goitre treated for cardiac disease, asthma, and nasal and laryngeal trouble when the underlying cause was not recognised.

Operation. The procedure is commenced as for routine thyroidectomy. The superior pole is ligatured and divided. The gland is pulled forwards and downwards, exposing the carotid vessels. A finger is passed along the line of cleavage in front of these vessels into the mediastinum. To find the line of cleavage the lateral thyroid veins must be divided. The finger now reaches the retro-sternal growth and sweeps round it to render it mobile. (It must be emphasised that in

passing the finger downwards the line of cleavage will not be found until the lateral thyroid veins running from the tumour to the internal jugular are divided.) It is easier and safer to pass the finger into the mediastinum from behind rather than in front of the tumour (fig. 1015). Pressure from below and traction from above will lead to the successful delivery of even large intra-thoracic goitres. Ligation of the inferior thyroid artery is seldom necessary. The goitre is delivered through the incision in the neck in a manner which resembles the delivery of an ovarian cyst or large myoma through an abdominal wound.

As soon as the intra-thoracic mass is delivered the cavity behind the sternum is packed with gauze. Before completion of the operation, the pack is removed and with the aid of a good head-light oozing vessels are secured. A cigarette drain should be left for some days within the cavity.

TOXIC GOITRE (GRAVES' DISEASE)

The treatment of hyperthyroidism by operation has now become so successful that the results in many cases may be described as dramatic. The success depends to a large extent upon pre-operative treatment. Operation should be postponed until the patient is gaining weight and the basal metabolic rate is falling. Complete rest and quietude, combined with the administration of Lugol's solution, usually bring about the desired result within a fortnight. In some cases many weeks must elapse for pre-operative treatment to become effective. More rarely still, modern methods of pre-operative treatment fail, and operation must then be performed in two or three stages. The first stage should be ligation of one superior thyroid artery. Considerable improvement often follows this operation. The probable reaction of the patient to major surgery can also be gauged by the amount of post-operative disturbance following this minor procedure (see page 1927). The efficacy of iodine as an aid to surgery has revolutionised the treatment of exophthalmic goitre. The dosage varies, ten drops of Lugol's solution two or three times a day before meals being usually sufficient. The effect of Lugol's solution is transitory, and if the patient responds well the operation should not be too long delayed. The gland in cases of toxic goitre is not so enlarged as in the simple non-toxic varieties. There may be no enlargement although the symptoms may sometimes be severe. Pronounced vascularity and sometimes fixity may render thyroidectomy difficult. The possibility of a toxic retro-sternal or lingual thyroid should be borne in mind (fig. 1016).

The goitre is exposed as in the operation already described.

Division of the platysma and sterno-hyoid and sterno-thyroid muscles is advised in order to get ample exposure and to prevent the necessity of much handling or pulling on the thyroid gland. The superior thyroid vessels are exposed and divided. The lateral and inferior veins are also clamped and divided. The sterno-mastoid muscle is retracted with the carotid sheath and access is obtained to the posterior portion of each lobe. Three or four hæmostatic forceps are pushed into the substance of the gland just in front of the inferior thyroid artery and the recurrent laryngeal nerve. The blades of the forceps should be inserted in a direction parallel to the course of the recurrent laryngeal nerve. The glandular substance is divided in front of these, the knife being carried backwards and inwards towards the isthmus. A very small amount of gland should be left behind. The isthmus is raised off the trachea and is also clamped and divided. The lobe is then removed. The second lobe is dealt with in a similar manner.

In cases of Graves' disease, rough handling and pressure on the gland must be avoided. Gentleness is essential in order to reduce to a minimum the extra dose of toxins which an operation liberates.



Fig. 1016.—LINGUAL GOITRE.

Comments. The desideratum is to perform the operation early before the toxic secretions have produced changes in the heart, kidneys, and other organs. It is remarkable, however, what a great improvement follows operation when myocarditis is present and renal, hepatic, or pancreatic function has become insufficient. The mortality following operation, however, rises in cases with auricular fibrillation. About 1.1 per cent of cases have sugar in their urine, but the operative risk is no greater when this is controlled with insulin. The dose of insulin required is increased in the presence of hyperthyroidism. Drainage through a stab wound is indicated after thyroidectomy in toxic cases.

The anæsthetic of choice is colonic oil-ether or gas and oxygen preceded by morphia, $\frac{1}{8}$ – $\frac{1}{6}$ gr., and atropine with local infiltration without adrenalin.

The emotional state of a patient must be carefully considered during the pre-operative management and during the administration of the anæsthetic. It is advisable to withhold the date of operation, and if colonic oil-ether anæsthesia is employed, the patient should be given rectal injections of saline some days previously so that the introduction of a catheter into the rectum will be regarded more as a routine than an ordeal. If gas and oxygen is chosen, a mask may with advantage be put over the nose for several days beforehand, so that when the time comes for operation, the patient will not realise that a new procedure is being contemplated.

In severe cases, the post-operative treatment should include the administration of oxygen, if feasible, in an oxygen chamber. In hyperthyroidism anoxæmia is often present, and there may be cyanosis from transitory air obstruction or from pulmonary œdema. Post-operatively the administration of morphia is not contra-indicated, and about a dram of Lugol's solution should be given in tap water per rectum. Subsequently 30 minims daily are given by the mouth until the patient is discharged from hospital.

To summarise the management of the average case of exophthalmic goitre :

(1) As a pre-operative preparation the patient should have complete rest, both mentally and physically.

Lugol's solution should be given for about ten days prior to operation in 10 minim doses three times a day. In crises the dosage should be increased to 60 or 100 minims daily until the acute symptoms disappear. Afterwards the dose is reduced until operation. Digitalis is contra-indicated unless in an exceptional case.

(2) At operation deep anæsthesia should be avoided, and every care taken to prevent the possibility either of injury to the recurrent laryngeal nerve or of post-operative hæmorrhage.

(3) Post-operative treatment. Lugol's solution is given as a routine in rather larger doses than during the pre-operative preparation, and should be continued in small doses (10 minims a day) for two or three months following operation.

Under such management in the Mayo Clinic, from January 1924 to January 1926, the operative mortality was 0.98 per cent. Such a figure proves that the patient with exophthalmic goitre runs a greater risk by postponing surgical treatment than by submitting to it.

At one time it was thought that adenomatous goitre was of no significance unless from the point of view of disfigurement and possibly

tracheal obstruction. It is now known that an adenomatous goitre may give rise to hyperthyroidism when it has been present, on an average, from ten to fifteen years, and that malignant changes are common. Probably 25 per cent of all adenomatous goitres become toxic. Toxic changes in the heart arise insidiously, and when this occurs the mortality following operation is higher than in cases of primary toxic goitre. Lugol's solution and other iodine preparations are contra-indicated in cases of toxic adenoma. Occasionally a case of mixed primary Graves' disease and toxic adenoma is encountered, and will respond to Lugol's solution prior to operation. In all probability many simple adenomata are converted into the toxic variety by iodine treatment. Rapid pulse, myocarditis, and cardio-vascular changes predominate in this type of toxic goitre, while exophthalmos is absent together with the central nervous phenomena so typical of Graves' disease.

THE PARATHYROIDS

Parathyroid tumours producing hyperparathyroidism are the cause of generalised osteitis fibrosa. Removal of the tumours is indicated in this condition. The tumours, as a rule, cannot be felt and remain unsuspected until the bony condition becomes apparent. Usually there is an abnormally high serum-calcium and an increased secretion of calcium in the urine. The phosphorus metabolism is invariably disturbed.

Operation. The usual collar incision is used as in cases of goitre. It is never certain on which side parathyroidectomy may have to be performed.

It is wise to ligature the superior thyroid vessels and to divide the lateral veins. The operation should then proceed on the lines illustrated and described for the removal of a retro-sternal goitre.

When the thyroid lobe is exposed, it is inspected on its anterior lateral surface for the presence of aberrant parathyroids. The lobe is then dislocated so as to expose the posterior structures. The inferior thyroid artery is located passing behind the carotid artery into the gland. The inferior parathyroid body may be exposed in this situation. The superior parathyroid may be found higher up at the junction of the upper and middle thirds of the thyroid margin, in the areolar tissue in the neighbourhood of the recurrent laryngeal nerve. The parathyroids are of a yellowish-brown colour, oblong or stellate, and may be mistaken for lymph glands or fatty tissue. If they are not at once

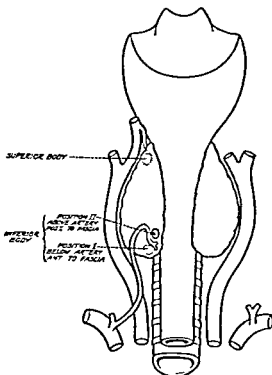


Fig. 1017.—POSITION OF PARATHYROID BODIES AS SEEN FROM BEHIND.
(Walton, *Br. Jr. Surg.*)

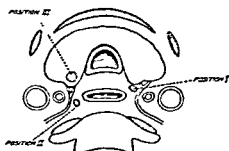


Fig. 1018.—RELATION OF PARATHYROID BODIES TO THYROID FASCIA.
(Walton, *Br. Jr. Surg.*)

localised the inferior thyroid artery should be ligatured and divided so as to give better exposure behind. In some cases the thyroid lobe should be removed. The number and position of the parathyroids is not constant. There is usually a superior and inferior gland on each side, but these numbers occasionally may be doubled. They lie between the thyroid fascia and the thyroid capsule, or in the substance of the thyroid gland and may be mistaken for small adenomata. An enlarged parathyroid sometimes extends downwards with the inferior thyroid veins in front of the carotid artery, and may lie under the sternum and the clavicle. A finger should palpate on either side of the trachea in the thorax if the tumour is not found at a higher level. In one case (Walton) a small typical parathyroid tumour was found behind the œsophagus, and a second large tumour the size of a plum (kidney coloured) was found lying immediately in front of the second and third dorsal vertebræ. It was easily dislocated upwards and its vascular pedicle, which ran with the inferior thyroid artery, was ligatured and the tumour removed.

Tetany is to be expected as a post-operative complication. To treat this condition, intravenous injections of 5 cc. of a 10 per cent solution of calcium chloride may be required. Calcium should also be

administered by the mouth (60 grs. of calcium lactate every four hours). "Tetanol" is a recent preparation of calcium lævulinate for intravenous injection in cases of tetany; 20 cc. is advised for a dose.

LIGATURE OF BLOOD-VESSELS

Ligature of the larger arteries of the neck is desirable as a preliminary to the removal of certain tumours. In this manner severe hæmorrhage is avoided. For example, the external carotid artery is frequently ligated prior to the removal of a parotid tumour or tumours of the upper jaw. The lingual artery is sometimes ligatured prior to removal of the tongue. Ligature may be required in cases of primary

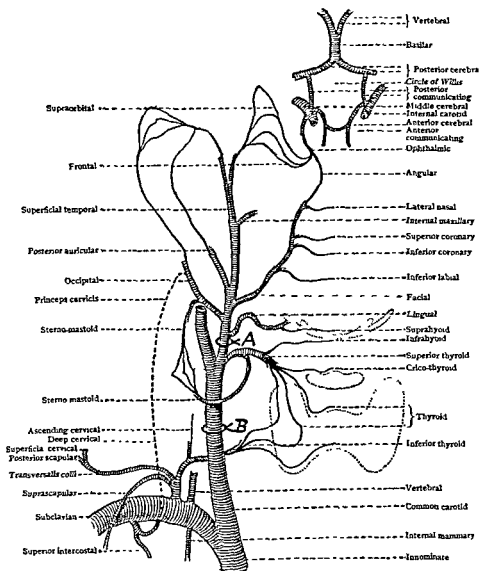


Fig. 1019.—GENERAL SCHEME OF COLLATERAL ANASTOMOSIS AFTER LIGATURE OF ARTERIES IN THE NECK.

(Wheeler's Operative Surgery.)

or secondary hæmorrhage following injuries self-inflicted or otherwise. Aneurysm of the neck is not very uncommon, and may require ligature of the innominate, subclavian, or carotid arteries for its cure. The collateral circulation after ligature is shown in figure 1019.

To expose the large arteries in the neck, an adequate incision is recommended. When operating on the cadaver, the anatomical structures are exposed and identified through a comparatively small opening, but in the living in the presence of a tumour such as an aneurysm, or in cases of hæmorrhage, much wider exposure is essential.

THE COMMON CAROTID ARTERY

The right common carotid artery commences at the bifurcation of the innominate at the level of the sterno-clavicular joint. The left artery arises from the arch of the aorta. The arteries terminate at the upper border of the thyroid cartilage by division into the internal and external carotid.

Compression of the Artery. Hæmorrhage can be temporarily controlled by compressing the vessel against the transverse process of the sixth cervical vertebra. If the vagus nerve is also compressed, a slowing of the pulse-rate will be noticed and probably some transient cardiac failure and breathlessness.

Position of the Patient. The shoulders are raised on a support as in all other operations about the neck. The extended head is turned to the opposite side.

OPERATIONS FOR LIGATURE OF THE COMMON CAROTID

The external carotid artery should be ligated instead of the common carotid whenever a choice exists. Serious cerebral anaemia sometimes follows occlusion of the latter artery. The anterior or inner edge of the sterno-mastoid muscle very nearly corresponds to the line of the artery. The middle of the incision lies opposite the cricoid cartilage; it should be 4-5 inches long. The skin and superficial fascia, with some branches of the superior cervical nerves and some tributaries of the external jugular vein, are divided with the first stroke of the knife. The inner border of the sterno-mastoid is accurately defined by opening its sheath of cervical fascia. The muscle is retracted outwards, care being taken not to include the carotid sheath in the grip

of the retractor. The carotid sheath is brought into view and probably lying on its surface will be seen the descendens hypoglossi nerve. The internal jugular vein lies to the outer side and behind the artery. The vagus nerve lies in the posterior part of the sheath, and the sympathetic nerve more directly behind. The omo-hyoid muscle is seen as it proceeds upwards and inwards towards the hyoid bone. This muscle may be divided or retracted downwards. The sheath of the carotid artery is opened on the inner side so as to avoid injury to the internal jugular vein, and the aneurysm needle is passed from without inwards for the same reason. Great care must be taken to keep the needle inside the sheath of the artery so as not to include the vagus nerve in the ligature. The artery is crossed at the site of ligature by the sterno-mastoid branch of the superior thyroid artery and frequently by the middle (lateral) thyroid veins.

If ligature of the artery is contemplated at a lower level (below the omo-hyoid) the internal jugular vein will be found to lie more anteriorly and may come in the way of the operator.

Sometimes it is wise to divide the omo-hyoid and the sterno-clavicular attachment of the sterno-mastoid muscle in order to obtain more room. The sterno-hyoid and sterno-thyroid muscles are retracted to the inner side. In the lower regions of the artery care must be taken of the recurrent laryngeal nerve and the inferior thyroid artery which lie behind.

Comment. The mortality following unilateral ligature has been estimated as follows: From hæmorrhage, 54 per cent; extirpation of tumours, 46 per cent; carotid aneurysm, 13 per cent; pulsating exophthalmos, 7 per cent. The younger the patient the better the prognosis. In short-necked individuals, and when difficulties are anticipated, a short transverse incision above the clavicle should be made to meet the lower extremity of the vertical incision. Both the sternal and the clavicular heads of the sterno-mastoid are divided and the entire muscle retracted outwards.

Makins emphatically advised occlusion of the jugular vein in all cases of ligation of the common carotid artery. He said that a capacious vein offers too ready a channel of exit for the diminished arterial supply and, furthermore, the small amount of blood after ligation of the artery is maintained for a longer period in the area supplied.

In subclavian aneurysm some authorities recommend the ligature of the common carotid in addition to the innominate artery, but this

double operation probably raises the percentage of gangrene in the limb. It is stated in the literature that the double ligature reduces the mortality, but this statement must be accepted with reserve.

Some cases of pulsating exophthalmos following an injury are due to the leakage of the internal carotid artery into the cavernous sinus. Eventually the condition produces blindness, but occasionally there is a spontaneous cure. Ligature of the common or internal carotid artery is indicated in such cases.

LIGATURE OF THE EXTERNAL CAROTID ARTERY

This artery lies very superficially about an inch from its origin at the level of the upper border of the thyroid cartilage. It is overlapped by the sterno-mastoid muscle. The artery at first has a slightly anterior and inner relationship to the internal carotid. The usual incision passes through a line from the upper border of the thyroid cartilage to a point immediately below the level of the ear. It is wise to extend this incision downwards and to expose the common carotid artery. The inner border of the sterno-mastoid is defined and the tendon of the digastric is sought for and retracted upwards. The lingual artery may be seen above and the superior thyroid below. The ligature is placed between these two arteries. The internal laryngeal nerve lies behind and slightly to the inner side of the artery. The hypoglossal nerve crosses the external carotid artery one inch above its origin.

The operation is attended with difficulty. Numerous lymphatic glands and veins obscure the view. The great cornu of the hyoid bone marks the position for the ligature.

Comments. The control of secondary hæmorrhage in wounds about the face and upper portion of the neck requires much surgical ingenuity. Ligature of the external carotid often only partially controls the hæmorrhage. Ligature of the common carotid artery may be followed by hemiplegia. In a certain number of cases exposure of the common carotid and compression between the finger and thumb gives sufficient time to deal with the hæmorrhage locally. It is a good plan when the hæmorrhage is stopped to encircle the common carotid with a piece of loose catgut with long ends. The wound is closed and the catgut is buried. If hæmorrhage recurs, the wound is quickly opened and the ends of the catgut are found; the artery is then tied. It must be

remembered that the external carotid lies first on the inner side and then behind and later to the outer side of the internal carotid.

If additional room is required, the incision should be carried up over the mastoid process. The sterno-mastoid muscle may be divided at its attachment to this process and pulled backwards, or the tip of the mastoid with the muscle attached may be removed with a chisel.

The posterior belly of the digastric may also require division. By these muscular divisions both the internal carotid and the external carotid and the internal jugular vein are well exposed.

LIGATURE OF THE SUPERIOR THYROID ARTERY

It has been already mentioned that the ligature of this artery is indicated as a preliminary procedure in cases of toxic goitre which have not yielded in a satisfactory manner to pre-operative preparation. Cases of severe hyperthyroidism may be rendered safe for thyroidectomy by ligature of one superior thyroid artery. This was pointed out by Kocher many years ago. If this comparatively minor operation is followed by a crisis the superior thyroid artery on the opposite side may be ligatured after an interval of some days or weeks. If no reaction follows the first procedure, thyroidectomy may be undertaken after a short interval. Sometimes it is wise to remove only one lobe and to complete the operative procedure at a later date. Ligature of the inferior thyroid arteries is a more difficult operation, and is not recommended in severe cases of hyperthyroidism (see page 1926).

Operation. The artery may be exposed by a collar incision as in thyroidectomy. The upper pole of the thyroid gland is isolated and the artery secured above the point of entry. It is better as a rule to ligature the artery by a more deliberate anatomical dissection. The external carotid is exposed in the manner already described. The superior thyroid will be found springing from the front of the lower portion of the main trunk near the bifurcation of the common carotid and $\frac{1}{4}$ inch below the tip of the cornu of the hyoid bone. The artery turns slightly upwards and forwards before taking a course downwards to reach the upper thyroid pole. At its origin it is covered by the anterior margin of the sterno-mastoid; lower down the omo-hyoid, sterno-hyoid and sterno-thyroid muscles hide it from view.

Comment. Some authorities believe that there are now no indications for preliminary ligation in cases of toxic goitre. They base this

opinion on the fact that the case of hyperthyroidism which does not respond to iodine will not improve after preliminary ligation. There is substance in this contention, but in the opinion of the writer it is wise to try the effects of ligation before attempting thyroidectomy in severe and uncontrolled cases.

LIGATURE OF THE INTERNAL CAROTID ARTERY

This operation is indicated in cases of intra-cranial aneurysm. It is of no avail in cases of hæmorrhage or aneurysm of the middle meningeal artery, which is a branch of the internal maxillary artery. The latter is the direct continuation of the external carotid. Tonsillar hæmorrhage is an indication for ligation of the internal carotid artery provided it is ascertained beforehand that the hæmorrhage is not from the tonsillar artery.

If the bleeding is from this source pressure on or subsequent ligation of the external carotid will control it.

Probably one of the greatest disasters in surgery is the mistaking of an aneurysm of the internal carotid artery for a tonsillar abscess. A dramatic picture of such a case is painted by the late J. B. Murphy. "First a few clots of blood slowly wriggled their way out, and a little faster a few more. Then came a rush of the arterial current with the full force of the spurting carotid. The patient strangling in his own blood struggled wildly, and his friend ran away in a panic, an abject deserter. Before Dr. Lee could gain control of the patient the latter had bled to death and the office was like a shambles from the struggle."

Operation. Expose the external carotid artery as already described. The internal carotid will be found lying slightly to the outer side and at a deeper level. The external carotid vessel should be gently retracted to the medial side. The sheath of the internal carotid is opened. The internal jugular vein lies in close proximity to the outer side. The vagus nerve lies between the vein and the artery in a posterior relationship. The aneurysm needle is teased round the artery from without inwards. There should be no hesitation in enlarging the incision or in dividing the sterno-mastoid in difficult cases.

LIGATURE OF THE LINGUAL ARTERY

This artery is divided anatomically into three stages. The first stage is from its origin from the external carotid (opposite the greater cornu of the hyoid bone) to the hyoglossus muscle. The second stage

lies under the hyoglossus muscle. Here the vessel lies on the middle constrictor of the pharynx and runs parallel to the cornu of the hyoid bone. The third stage proceeds upwards along the anterior border of the hyoglossus to become the ranine artery under the tongue. The steps of the operation of ligature in the first stage are identical with those described for ligature of the external carotid artery.

The second stage is ligated in the following manner :

Operation. The shoulders are raised and the head turned to the opposite side.

A curved incision is made from below the symphysis menti passing down to the hyoid bone and terminating at the angle of the jaw. The skin, superficial fascia and platysma muscle are divided. The deep cervical fascia covering the submaxillary gland is incised, the gland is mobilised and retracted upwards towards the face. The boundaries of the digastric triangle are now defined. The anterior belly covering the mylo-hyoid muscle is seen in front. The posterior belly of the digastric is defined. The floor is formed by the thin fibres of the hyoglossus muscle running in a vertical direction. The hypoglossal nerve is found lying on the hyoglossus muscle, and disappearing in front under the mylo-hyoid. The nerve is sometimes attached to the deep surface of the submaxillary gland and does not come into view. When it is seen it is retracted upwards, together with the ranine vein. A finger is introduced into the lower part of the wound to feel for the hyoid bone. At this stage a useful manoeuvre is to press the hyoid bone upwards from the opposite side and to maintain this position by passing a hook round it. Thus the field of operation is rendered more superficial. The fibres of the hyoglossus muscle are now carefully cut through in a horizontal direction for about $\frac{1}{4}$ inch, close to the hyoid bone and to the mylo-hyoid muscle. The artery presents itself and a needle is passed round it from above downwards. It must be remembered that the fibres of the hyoglossus are very thin, and the pharynx may be opened if the fascial plane which separates the muscle from the middle constrictor of the pharynx is not recognised.

Comment. The arteries may require ligature when there is hæmorrhage from malignant disease of the tongue or as a preliminary to excision of the tongue.

It is not necessary to suture the opening of the hyoglossus muscle when closing the wound.

LIGATURE OF THE INNOMINATE ARTERY

Ligature of this artery is usually required in cases of aneurysm of the subclavian artery involving the first or second stage. The writer ligatured the innominate artery for subclavian aneurysm in 1932. The following description of the case was published in *Surg., Gyn., and Obstet.*, Feb. 15, 1933, Vol. lvi (Murphy Oration):

Ligature of the Innominate Artery for Right Subclavian Aneurysm. In May 1932 I ligatured the innominate artery for aneurysm of the subclavian artery involving the first and second stage. The patient was



Fig. 1020.—LIGATURE OF THE INNOMINATE ARTERY. X-RAY OF BULLET IN THE NECK CAUSING RIGHT SUBCLAVIAN ANEURYSM.

wounded in 1915; pieces of shrapnel were shown by X-rays, scattered in the region of the right shoulder joint, and portions of a bullet could be felt to the right of the suprasternal notch under the insertion of the sterno-mastoid muscle (fig. 1020). The wall of the artery was apparently injured, but the aneurysm did not become evident until 1923, thirteen years after the wound. It steadily increased in size until the swelling above the clavicle reached the size of a duck's egg. The right recurrent laryngeal nerve was paralysed. The radial pulse was not affected, and the blood-pressure was the same on both sides. The X-rays demonstrated some calcification within the sac. The Wassermann reaction was negative.

In some respects this tumour was not typical of aneurysm; there was no bruit, expansile pulsation could not be detected; there was no

difference in the carotid or radial pulses when compared with those of the other side.

An operation was designed to ligature the subclavian artery behind the scalenus anticus muscle at the commencement of the second stage. The line of incision is shown in fig. 1021. The middle portion of the clavicle was turned downwards on the chest with its pectoral attachments. The aneurysm was laid bare and the bullet was removed. The external and internal jugular veins were found obstructed and distended. The supra-clavicular and transversalis colli arteries spread transversely across the upper portion of the tumour (fig. 1022). The scalenus anticus muscle had disappeared and the phrenic nerve

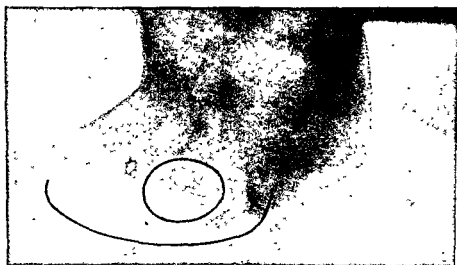


Fig. 1021.—LIGATURE OF THE INNOMINATE ARTERY. THE CURVED LINE MARKS THE EXTENT OF THE INCISION. THE CIRCLE INDICATES THE POSITION OF THE ANEURYSM AND X THE UNDERLYING BULLET.

was not located. It was soon seen that the sac extended to the bifurcation of the innominate artery and that ligature of the subclavian vessel was impossible. It was obvious that without further removal of bone the innominate artery could not be exposed behind the sterno-clavicular articulation without the rough handling of the aneurysm, which had led to disaster in many recorded cases. With chisel and mallet the inner end of the clavicle together with the right half of the manubrium sterni (leaving the sterno-clavicular joint intact) was separated, and retracted upwards and to the left. The innominate artery was now visualised in its entire length. The innominate veins were not seen; the pleura caused no embarrassment, and the nerves remained hidden.

Two ligatures of No. 2 chromicised catgut were passed around the artery distal to the thyroidea ima branch. They were gradually

tightened, care being taken not to cut through the inner coats of the vessel. Pulsation at once ceased in the aneurysm and the radial pulse disappeared. Proximal to the ligature each pulsation appeared like a sledge-hammer blow upon the occluded portion. It looked as if the assault could not be resisted. For this reason, an additional single ligature of catgut was placed around the artery near its origin from the aorta. The thyroidea ima was ligatured with fine silk (fig. 1022). The divided portions of the sternum and clavicle were replaced in position and held by catgut passed through drill-holes. Recovery was uneventful but for some downward displacement of the divided portion of the clavicle. In three days the radial pulse reappeared, and within a week it was full and synchronous with the pulse on the opposite side. The patient was reported as cured two years after operation.

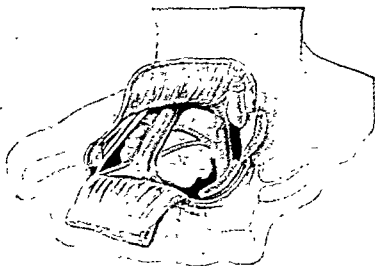


Fig. 1022.—LIGATURE OF THE INNOMINATE ARTERY. PLAN OF APPROACH.
(Author's case.) (CARSON'S *Modern Operative Surgery*)

The experience of this case suggests that ligature of the innominate artery is not a difficult operation provided the old inadequate methods of approach are abandoned.

Up to and including the year 1922, according to Ballance, there had been 57 ligatures of the innominate artery, with 19 recoveries (*Brit. Jr. Surg.*, IX, 438).

A case of ligature of the innominate artery was exhibited by Mr. Coppinger of the Mater Hospital, Dublin, at the Section of Surgery of the Royal Academy of Medicine in Ireland, on February 24, 1893. The record states that this was the first successful case of ligature of the innominate artery ever exhibited at any medical society in Europe.

The ideal operation for subclavian aneurysm is excision of the sac after proximal and distal ligation. This has been successfully performed by Halsted (*Bull. Johns Hopkins Hosp.*, 1892, July-August), who removed with the aneurysm a portion of the subclavio-axillary vein, and also by Braithwaite (*Brit. Jr. Surg.*, VII, 90). The possibility of ligaturing either the first or second portion of the artery is a condition precedent to excision. Both portions were involved in the sac in the case I have just mentioned.

In a volume (London: The New Sydenham Society, 1881) on the works of Colles, by Robert McDonnell, president of the Royal College of Surgeons in Ireland in 1877, the operation of tying the subclavian artery is admirably described. Colles attempted more than once to ligature the first stage of the artery, a far more difficult procedure than ligation of the innominate. He thought that ligation of the first stage on the left side was almost an impossibility, but A. K. Henry (*Brit. Jr. Surg.*, X, 367) has shown that this operation is greatly simplified by an approach from behind.

Comment. The needle is passed from right to left to avoid the pleura and right innominate vein.

A few cases of aneurysm of the innominate artery treated by ligation of the trunk near its origin are recorded. The most recent case is described by H. S. Souttar (*B.M.J.*, June 16, 1934).

Mr. Granville Chapman and Mr. C. J. MacAuley (Dublin) ligatured the innominate successfully for subclavian aneurysm in 1929 and 1932 respectively.

LIGATION OF THE SUBCLAVIAN ARTERY

The subclavian arises on the right side from the innominate artery behind the right sterno-clavicular articulation and on the left side at a slightly lower level from the aorta. The scalenus anticus muscle divides the artery into three stages. The second stage lies deep to the tendon of this muscle. An arched line drawn with the convexity upwards from the sterno-clavicular articulation to a point above the centre of the clavicle marks the course of the vessel.

Position of the Patient. The sand-bag is placed under the shoulders. The shoulder is depressed and the head rotated to the opposite side.

Operation. The skin is drawn down over the clavicle with one hand and is divided with the superficial tissues down to the bone. The

incision extends from $\frac{3}{4}$ inch outside the sterno-clavicular articulation to beyond the central point of the clavicle. The incised skin is allowed to retract upwards and the operation is continued above the clavicle.

The deep fascia is cut through and the external jugular vein retracted or divided. The trapezius muscle is usually exposed at the outer angle of the wound and the sterno-mastoid at the inner. The posterior belly of the mylo-hyoid is found just above the clavicle and is pulled upwards. The finger can now be passed down behind the clavicle, and if the head be kept rotated well over to the opposite side, the tense tendon of the scalenus anticus muscle can be felt gaining insertion into the scalene tubercle of the first rib. This is a sure guide to the artery. The transverse cervical artery above and the superior scapular artery below must be preserved. The cords of the brachial plexus are exposed lying to the outer side and above the subclavian artery. The lowest cord (that formed from the last cervical and first dorsal nerve) lies in very close proximity to the vessel. The subclavian vein lies more in front and at a lower level than the artery. When the scalenus anticus tendon is found at its insertion into the scalene tubercle of the first rib, no difficulty will be experienced in securing the artery as it sweeps outwards, to become the axillary artery at the outer border of the first rib. The aneurysm needle is passed from above downwards (from the nerves), a finger guiding it below to prevent injury to the vein.

LIGATURE OF THE LEFT SUBCLAVIAN ARTERY IN ITS FIRST STAGE

It is almost impossible to reach the first stage of the subclavian artery on the left side by an anterior approach, especially when an

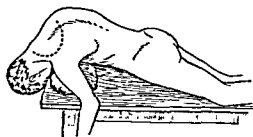


Fig. 1623.—LIGATURE OF THE LEFT SUBCLAVIAN ARTERY IN ITS FIRST STAGE. HENRY'S OPERATION. LINE OF INCISION. SCAPULA ABDUCTED.

aneurysm is present. A. K. Henry has admirably described the posterior approach. (*Exposure of Long Bones and other Surgical Methods*, p. 45, John Wright & Sons.) Although the artery lies at a

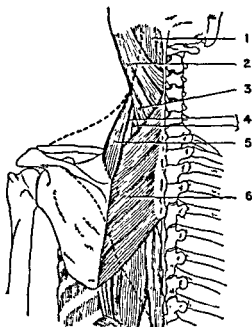


Fig. 1024.—LIGATURE OF THE LEFT SUBCLAVIAN ARTERY IN ITS FIRST STAGE. HENRY'S OPERATION, SHOWING MUSCLE STRATA UNDER THE TRAPEZIUS.

1. Complexus.
2. Splenius Capitis.
3. Splenius Cervicis.
4. Cervical extension of Erector Spinae.
5. Levator Scapulae.
6. Rhomboids.

1. Complexus.
2. Splenius Capitis.
3. Splenius Cervicis.
4. 1st Dorsal Transverse process.
- 1a. Complexus.

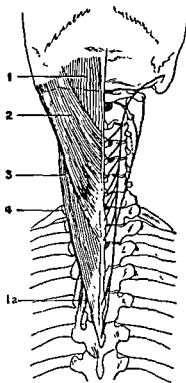


Fig. 1025.—LIGATURE OF THE LEFT SUBCLAVIAN ARTERY IN ITS FIRST STAGE. HENRY'S OPERATION SHOWING MUSCLE STRATA.

considerable depth it can be easily identified by depressing the apex of the lung with its surrounding pleura. There are no nerves or veins in posterior relationship to the artery. The muscles which are traversed in order to reach the vessel are the trapezius, the rhomboids, and the serratus posticus superior. Deep to these muscles of the shoulder girdle are some cervical extensions of the erector spinæ which require division. The first goal to be sought is the second rib. This is removed. It may be mistaken for the first rib, but can be identified when it is remembered that the second rib lies dorsal to the first rib and that the latter passes almost directly forwards from the costo-transverse articulation. The first rib is, therefore, difficult to palpate. After division of the trapezius and other muscles passing to the scapula, the transverse process of the first dorsal vertebra is sought with the finger.

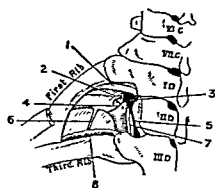


Fig. 1026.—LIGATURE OF THE LEFT SUBCLAVIAN ARTERY IN ITS FIRST STAGE. HENRY'S OPERATION.

1. First Dorsal Nerve.
2. Costo-Cervical Trunk.
3. Cervico-Dorsal Ganglion of Sympathetic Trunk concealing Vertical Artery.
4. Ansa-Subclavia.
5. Sympathetic Cord.
6. Internal Mammary Artery.
7. Inferior Cardiac Branch of Sympathetic Cord.
8. Pleural Dome.

It lies at the level of the seventh cervical spine three fingers' breadths from the middle line. From this point the finger slips on to the transverse process of the second rib. (It is advisable, by X-rays, to exclude the presence of cervical ribs before operation is undertaken.) The depth of the proximal part of the artery from the dorsal surface is about 3 inches, but after the muscles have been divided, the artery is as near to the thoracic wall behind as it is in front.

Operation. A good head-light is essential or some artificial light passed into the wound. No deep cavity can be illuminated by lights over the operation table.

Position of the Patient. The patient lies prone; a sand-bag is placed under the upper portion of the chest and the arm is allowed to hang downwards over the edge of the table. By this means the space

between the vertebral border of the scapula and the spine is at a maximum (see fig. 1023).

The seventh cervical spine is located and a point four fingers' breadths above it and one finger's breadth to the right of the middle line is marked. Another point is taken a little more than a hand's breadth below the seventh spine and also marked. A third point marks the position of the centre of the spine of the scapula. A curved incision reaching outwards to the middle of the spine of the left scapula is made joining these three points. The incision is carried down to the sheath covering the trapezius muscle. The flap of skin and subcutaneous tissue is raised and turned over to the right. A vertical cut is now made to the left of the vertebral spine; it divides the trapezius, the rhomboids, and the serratus posticus superior. The middle of the incision exposes the silvery tendon of the serratus. The divided muscles are retracted outwards and the splenius muscle is exposed. At the level of the seventh spine three fingers' breadths from the middle line, the tip of the first left dorsal transverse process is identified. The second rib is then located, and this is cleared together with its transverse process. The latter is divided and removed. The largest possible portion of the rib, including the entire neck, is then excised. The pleura is pushed away with the finger from the deep aspect of the proximal end of the divided rib. The sympathetic cord is now seen close to the vertebral body lying on the pleura like a narrow tape. The pleural dome should be gently pushed downwards and outwards from the vertebra. It will be held at one point by the superior intercostal artery. This vessel is divided and tied. The pleural dome can then be freely depressed and the pulsations of the subclavian artery are felt by the finger. Henry states that the removal of the transverse process together with the costal neck of the second rib permits of this direct approach.

A broad retractor such as is used in prostatic operations to depress the fundus of the bladder or Deaver's gall-bladder retractor keeps the lung and pleura out of the field. The artery is isolated under direct vision by blunt dissection. Its sheath is opened. An aneurysm needle with a slot eye is passed with the left hand from within outwards, and the ligature completed.

It will be seen from the above description that an approach to the first stage of the subclavian artery is obtained by costo-transversectomy at the level of the second rib on the left side. Depression of the pleural dome leaves the artery naked from the aorta to the first rib. No nerves, veins, or other important structures intervene between the operator and the vessel.

TENOTOMY OF THE SCALENUS ANTICUS MUSCLE

This operation is performed to relieve pressure on the subclavian artery and the surrounding nerve trunks. Pressure effects are usually attributed to the presence of a cervical rib or sometimes by stretching of the nerves and artery against the normal first rib.

A. W. Adson of the Mayo Clinic and others have shown that simple division of the scalenus anticus muscle relieves the pressure more effectively than the removal of a rib.

Operation. An incision is made in the lower portion of the neck extending from the sterno-clavicular articulation obliquely backwards and upwards into the posterior triangle. The attachment of the

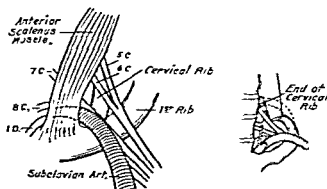


Fig 1027.—CERVICAL RIB. DIVISION OF THE SCALENUS ANTICUS MUSCLE. (Mayo Clinic.)

sterno-mastoid muscle to the clavicle is exposed and divided. The upper portion of the muscle is retracted towards the middle line exposing the tendon of the omo-hyoid and the attachment of the scalenus anticus. The phrenic nerve is seen crossing the scalenus obliquely from the lateral to the mesial border. It is dissected free and retracted mesially. The subclavian artery is observed deep to the scalenus anticus. The pleura can be recognised to the inner side. Before dividing the attachment of the scalenus anticus at its insertion, the deep relationship of the subclavian artery must be remembered and also that the pleura is in close relationship to the inner border of the muscle. The superficial fibres of the scalene muscle are first divided; they retract and bring the deeper fibres into view. These are divided in turn until division is complete. When the muscle has been completely divided, the brachial artery drops forward and all signs of compression disappear (fig. 1027).

It will be realised that this comparatively simple operation compares favourably with the difficult resection of a cervical or normal first rib and the results are better.

Comment. Pressure symptoms on the subclavian artery and on the nerve trunks do not arise, as a rule, until adult life. Delay in the onset of symptoms may be due to the ossification of the rib which is complete about the twenty-fifth year. In young children, however, very definite symptoms sometimes arise similar to those seen in adults. In the case of children, operation is seldom necessary.

EVULSION OF THE PHRENIC NERVE (see also page 2123).

The operation is undertaken as an adjunct to thoracoplasty in pulmonary tuberculosis, and in cases of artificial pneumothorax where pulmonary collapse is unsatisfactory. In pulmonary tuberculosis

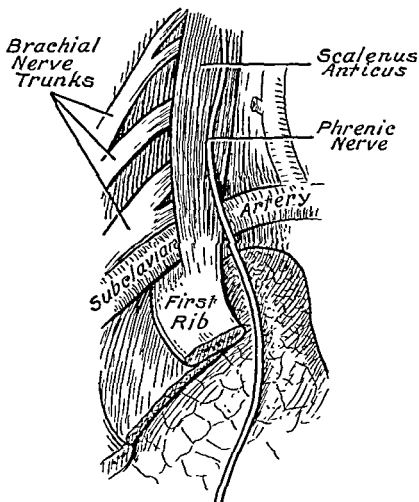


Fig. 1028.—DIAGRAM SHOWING RELATIONSHIPS OF THE PHRENIC NERVE, SUBCLAVIAN ARTERY, NERVE TRUNKS AND SCALENUS ANTICUS MUSCLE.

phrenic evulsion has a beneficial effect on the local lesion. In cases of hæmoptysis phrenicectomy is often disappointing. Phrenicectomy is also of value as a preliminary to the operation for the cure of herniæ through the diaphragm. The hernial ring is relaxed and spasm of the muscle is prevented. The defect in the diaphragm can be closed without tension.

The operation is also indicated in cases of bronchiectasis. In this and other conditions where lung collapse is desired, evulsion of the nerve is combined with artificial pneumothorax, extra-pleural resection of the ribs or partial lobectomy. Probably the most frequent indication for the operation is early unilateral tuberculosis of the lower pulmonary lobe.

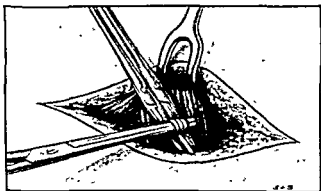


Fig. 1029.—EVULSION OF THE PHRENIC NERVE.

Operation. This should always be performed with local infiltration anæsthesia. An incision is made along the posterior border of the sterno-mastoid muscle in the lower two-thirds of the neck. The sterno-mastoid is retracted medially and the phrenic nerve is found lying on the scalenus anticus. The nerve is easily found behind and external to the carotid sheath. It can be exposed equally well by a transverse incision, about 2 inches in length, above the clavicle and to the outer side of the sterno-mastoid muscle. The nerve is divided and the distal end held by artery forceps. It is then twisted round the forceps and as much of the nerve as possible is removed from the deeper regions of the neck (fig. 1029). The amount which can be removed in this way varies from 3 to about 15 inches.

Evulsion is essential in order to tear or remove the accessory branch from the fifth root which joins the phrenic within the thorax.

Comment. In about 30 per cent of cases an accessory phrenic nerve is present. It often takes origin from the 5th cervical root. It joins the main phrenic 4 to 5 cms. below the first rib.

OPERATION FOR WRY NECK (TORTICOLLIS)

In all cases of wry neck an X-ray photograph of the cervical region should be obtained before operation. If this precaution is omitted malformations and anomalies of the cervical vertebræ, if present, will escape detection. No improvement will follow operation in such cases. The shortening of the sterno-mastoid muscle and other soft structures in the neck is secondary to the osseous defect.

Mild cases of torticollis respond to manipulation, fixation and exercises.

Operation. Subcutaneous division of the tendon of the sterno-mastoid is an unsatisfactory and obsolete operation. A transverse incision should be made above the inner end of the clavicle, extending inwards beyond the sterno-clavicular joint. The skin is pulled upwards while making the incision, so that the resultant scar will lie at as low a level as possible.

The sterno-mastoid muscle is exposed. The sternal and clavicular heads are carefully divided. The internal jugular vein is in close deep relationship with the latter; it should be clearly seen after division of the tendon. Many constricting bands of cervical fascia in addition to the sheath of the sterno-mastoid muscle require free division. It is often wise to use a director for division of these bands in order to avoid any possibility of wounding the internal jugular vein. In advanced cases it is advisable, in addition, to divide the insertion of the scalenus anticus muscle in the manner already described.

An alternative operation is to divide the sterno-mastoid at its attachment to the mastoid process and superior curved line.

A vertical incision is made over the mastoid process exposing the insertion of the muscle. A blunt instrument is passed under the tendon before it is divided.

This operation has the advantage of the scar being covered with hair and probably more over-correction can be obtained than when the low operation is performed. It has, however, some disadvantages which cannot be elaborated; suffice it to say that the low operation is followed by good results, and is preferred by such authorities as the late Sir Robert Jones. In the case of wry neck, as in every other field of surgery, the post-operative care is more important than the operative procedure. The patient must lie for twenty-four hours with the head bandaged or supported in the over-corrected position. This

position must be maintained by a plaster cuirass for at least six weeks. Corrective exercises subsequently are necessary to avoid the possibility of relapse.

NECKLESS MEN

This title has been given to cases in which absence of the neck is suggested. The head appears to rest directly on the trunk. The title is misleading inasmuch as the condition is seen in both men and women in the proportion of about three to one. Pritchard recently demonstrated a female child aged 3 suffering from the deformity. Klippel and Feil of Paris in 1912 drew attention to the nature of this congenital abnormality (Klippel-Feil's disease). There is marked limitation of the movements of the head in all directions. Scoliosis or



Fig. 1030.—NECKLESS MEN.
(*Med. Ann.*)

a kyphoscoliotic curve is present. The appearance of the patient suggests old-standing sub-occipital Pott's disease or advanced torticollis.

The vertebral column is replaced by a fused bony mass without any signs of inter-vertebral spaces.

Usually there is an absence of fusion of the neural arches of the first seven or eight vertebræ (spina bifida).

There is no evidence of heredity or familial predisposition. The cosmetic appearance can be considerably improved by high plastic operations on the skin and deep fascia (Gillies).

PART VIII

BREAST

by

R. J. McNEILL LOVE

BREAST

Anatomy. The mammary gland possesses no capsule and in consequence its limits are somewhat variable. As a rule the gland extends from the second rib above to the sixth intercostal space below and from the mid-axillary line externally to the lateral border of the sternum on the inner side.

A prolongation, the axillary tail, extends under cover of the pectoralis major muscle as far as the third rib. Fibrous strands, the ligaments of Cooper, connect the superficial fascia with the connective tissue septa which divide the gland into lobules. In cases of carcinoma it is the infiltration of these ligaments which causes dimpling of the overlying skin.

The breast lies upon the fascia, covering the following muscles :

Above and to the inner side—pectoralis major.

Below—external oblique and rectus abdominis.

Outer side—serratus magnus.

The nipple is situated slightly below the centre of the breast, and on its surface fifteen to twenty lactiferous ducts open.

The surrounding areola is dotted with large sebaceous glands, the tubercles of Montgomery, which enlarge during lactation. As in the case of sebaceous glands elsewhere, obstruction to a duct is liable to result in a sebaceous cyst.

The breast derives its arterial supply from the long thoracic branch of the axillary artery and the perforating branches of the internal mammary artery.

Lymphatic drainage. The lymph vessels of the breast are cutaneous and glandular.

The cutaneous vessels form the sub-areolar plexus, from which lymphatics pass towards the margin of the breast and unite with the lymphatic plexus in the fascia covering the pectoralis major.

The glandular lymphatics ramify in the septa which divide the

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The glandular lymphatics ramify in the septa which divide the

breast into lobules, and communicate both with the cutaneous lymph vessels and the fascial plexus overlying the pectoralis major (fig. 1031). The connections of the fascial plexus are of extreme importance in tracing the extension of carcinoma, and may be summarised as follows :

Superiorly—Infra-clavicular glands, which lie on the costo-coracoid membrane. The supra-clavicular glands are sometimes affected either by connections with the infra-clavicular glands or by lymphatics which pass to them directly over the clavicle.

Internally—through the upper intercostal spaces to glands along the internal mammary vessels and thence to the mediastinal glands.

Inferiorly—by vessels which cross the costal margin and communicate with lymphatics on the upper surface of the diaphragm, and possibly via the falciform ligament to the liver.

Externally—to the axillary glands, which are divided into four more or less distinct groups :

(a) *Pectoral glands* (or internal group) which lie on the serratus magnus muscle and surround the long thoracic artery.

(b) *Subscapular glands* (or central group), which lie on the posterior wall of the axilla, and which intimately surround the subscapular vessels.

(c) *External glands*, which lie in front of and along the inner side of the axillary vein.

(d) *Apical glands*, which are situated on the summit of the axilla.

The arrangement of the lymphatic glands concerned in the drainage of the breast is diagrammatically shown in figure 1032.

MALFORMATION

Congenital anomalies of the breast are not uncommon, the following being some of the more important :

Amazia—absence of one breast or very rarely absence of both, occurs more commonly in males than in females. It is usually associated with other deficiencies, notably lack of development of part or the whole of the pectoralis major muscle, and

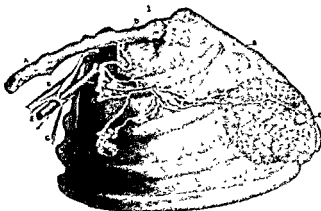


Fig. 1031.—SPECIMEN PREPARED BY SIR ASTLEY COOPER IN 1825. THE LYMPHATICS ARE INJECTED WITH MERCURY. THE SUB AREOLAR AND MARGINAL LYMPHATICS ARE CLEARLY SHOWN, ALSO A LYMPHATIC PASSING TO THE SUPRA-CLAVICULAR GLANDS.

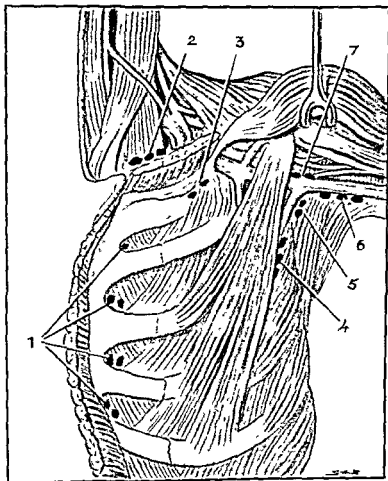


Fig. 1032.—THE LYMPHATIC GLANDS COMMONLY AFFECTED BY A CARCINOMA OF THE BREAST.

1. Intercostal.
2. Supra-clavicular.
3. Infra-clavicular.
4. Pectoral.
5. Subscapular.
6. External.
7. Apical.

occasionally absence of the pectoralis minor muscle and a portion of the ribs (fig. 1033).

Polymazia—or the presence of supernumerary breasts, is more often seen in females. They usually occur somewhere along the "milk line," i.e. a line extending from the axilla to the groin. Occasionally, however, ectopic breasts are present in other situations (fig. 1034). Accessory breasts, provided they are capable of function, are stated to be more prone to pathological processes than breasts in the normal situation.

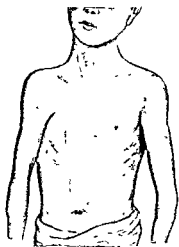


Fig 1033—ABSENCE OF THE RIGHT BREAST, ASSOCIATED WITH NON-DEVELOPMENT OF THE PECTORALIS MAJOR AND MOST OF THE PECTORALIS MINOR MUSCLES.

(After F. B. Jefferies.)

Athelia—is a rare condition characterised by absence of the nipple.

Polythelia—or the presence of supernumerary nipples, is comparatively common. Occasionally two or more nipples are present on the same areola, and each may function independently.

Gynacomazia—is a term applied to enlargement of one or both breasts in the male. This condition has been observed to follow destruction of the testicles by injury or disease. In the majority of cases the increase in size is due to deposits of fat, but cases have been recorded in which milk has been secreted.

Diffuse Hypertrophy—is more common in hot than in temperate climates. The condition usually manifests itself about puberty and the nipples are unaffected. Disability results from excessive size and weight (fig. 1035).

Treatment. Many malformations of the breast or nipple require no treatment, but accessory breasts or nipples are readily removed if desired. Amputation of a hypertrophic breast is associated with considerable hæmorrhage and shock.

DISEASES OF THE NIPPLE AND AREOLA

Retraction of the nipple is due to congenital malformation, fibrosis following inflammation, or infiltration of lymphatics associated with a slowly-growing carcinoma. In some cases, due to fibrosis, lactation

may be rendered possible by repeated traction, aided if necessary by suction with a breast pump.

Cracks and fissures are very liable to infection, which tends to spread along the ducts into the breast, and so cause a mammary abscess. The condition can usually be prevented by prophylactic treatment. Retraction should be corrected, and during the last few weeks of pregnancy the nipples should be bathed with a mild antiseptic and hardened with surgical spirit. When suckling commences, the nipples are washed after nursing, carefully dried, and dusted with antiseptic powder.



Fig. 1034.—AN ACCESSORY AND FUNCTIONING BREAST ON THE LEFT THIGH.

(After Wiskowski.)

Should a crack or fissure appear, suckling must be discontinued, as the consequent irritation promotes infection. Antiseptic lotions are applied, such as 2 per cent potassium permanganate, and a breast pump is used to withdraw milk until the fissure is soundly healed.

Chancre of the nipple is now rare in this country, as the wide range of artificial foods has rendered the employment of a wet nurse unnecessary. As with other extra-genital chancres the classical feature of dense



Fig. 1033.—HYPERTROPHY OF BOTH BREASTS IN A GIRL AGED SIXTEEN YEARS.



Fig. 1035.—PAGET'S DISEASE IN A MALE BREAST, OF SEVEN YEARS DURATION. A SMALL PATCH OF CARCINOMA HAD DEVELOPED IN THE UNDERLYING BREAST.

induration or "cartilaginous base" is often absent. The condition is painless, but the axillary glands are enlarged and firm. Primary syphilitic sores are occasionally produced by contact with the mouths of infected persons apart from lactation.

Paget's disease of the nipple, first described in 1874, is to be distinguished from true eczema, which is usually bilateral, and lacks the sharply-defined edge and slight infiltration of Paget's disease. In the early stages greyish scales appear on the nipple, and when desquamation occurs a raw, rosy-red area appears. This area gradually extends, and the nipple is eroded and gradually disappears (fig. 1036).

According to Sir James Paget carcinoma of the breast developed within two years, but now many cases are on record in which this period is much longer. However, it appears certain that should the patient live for a sufficiently long period carcinoma of the underlying breast will ultimately develop. Formerly some surgeons held the view that a carcinoma always preceded Paget's disease, which was due to consequent lymphatic obstruction of the areola, and consequent oedema and ulceration. However, serial sections of the breast in early cases of Paget's disease have failed to reveal any evidence of carcinoma, which proved that the condition must be a predisposing cause of breast carcinoma rather than secondary to this condition.

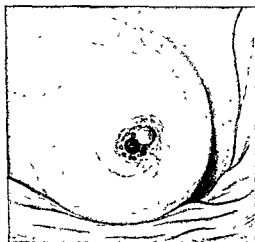


Fig. 1037.—MELANOMA OF THE NIPPLE.
(From a drawing in the R.C.S. Museum.)

Probably Paget's disease commences as a carcinoma of a lactiferous duct adjacent to the nipple. The malignant changes are possibly encouraged by irritation due to decomposing debris which is retained in the duct. In addition to the cutaneous spread the cells lining the duct are affected, and so the cancerous tendency spreads to the glandular cells which eventually become carcinomatous.

It has recently been suggested that these slowly-growing carcinomata spread, not by permeation, but by cancerous metaplasia of adjacent cells.

A microscopic section from a case of Paget's disease reveals small-celled infiltration and proliferation of the Malpighian layer. Characteristic Paget's cells (psorosperms) are present which are larger in size, with homogeneous cytoplasm and deeply-staining nuclei. They were formerly regarded as parasitic but now most pathologists believe them to be derived from prickly cells.

Treatment consists in performing a radical amputation of the breast. The prognosis is good provided the formation of a breast carcinoma is forestalled.

Papilloma of the nipple continues to grow in size until it is removed. The pedicle is always narrow and if ignored it will eventually dangle for several inches. Excision is readily performed under local anaesthesia.

Melanoma of the nipple is uncommon, but is liable to occur in the areola, as in other pigmented tissues (fig. 1037). The inexorable malignancy of melanomata is exemplified here as in other situations, and even complete removal of the breast and axillary glands is only too liable to be followed by occurrence elsewhere.

PATHOLOGICAL DISCHARGES FROM THE NIPPLE

The causes of pathological discharges from the nipple are summarised as follows :

Blood-stained—duct papilloma ; duct carcinoma.

Serous—early duct papilloma ; early interstitial mastitis.

Grumous—old-standing interstitial mastitis, when the discharge is often brown or green in colour, owing to the presence of altered blood.

Purulent—from an acute abscess, when pus is mixed with milk ; rarely from a chronic abscess.

Milky—rarely in cases of gynæcomazia or galactoceles.

INFECTION

Acute mastitis is particularly liable to occur in infancy, at adolescence, and in association with lactation. As in any part of the body, an acute abscess occasionally follows metastatic infection of a hæmatoma caused by injury.

Mastitis of infants. For a few days after birth physiological swelling of the breast is a normal condition and occasionally a few drops of milky fluid exude from the nipples. This is probably due to the hormone in the mother's blood, which stimulates maternal lactation, also affecting the breasts of the infant. This reaction in

the child is naturally slight and only temporary. Manipulation of the breast by an ignorant midwife, in order to "break the strings," predisposes to infection, but this practice is dying out with the older generation of midwives.

Physiological mastitis needs no treatment. If inflammation occurs treatment is conducted on accepted lines, and a small radial incision may be necessary.

Mastitis of adolescents. Some swelling and tenderness of the breasts between the ages of fourteen and sixteen is not uncommon in either sex. If friction is applied, infection along the ducts is encouraged. If symptoms warrant interference a belladonna plaster is applied, but the condition usually disappears spontaneously in a few weeks. In the rare cases in which suppuration occurs an incision is necessary.

Mastitis of lactation usually follows a crack or fissure of the nipple. Cleaning of baby's gums with a swab is a practice which should be abolished, as small ulcers are liable to result and so infect a crack or fissure. In cases where no crack is present infection presumably gains entrance along the lactiferous ducts. The condition is predisposed to by retention of milk in one or more lobules of the breast owing to obstruction of the corresponding ducts by clot. Clotting of milk in a duct is encouraged by the entrance of staphylococci. Therefore, should portions of the breast remain firm and tender after suckling, a breast pump should be used, or gentle expression performed manually, i.e. "milking the breast." This type of mastitis is especially prone to occur at the beginning and end of lactation. It is most common during the early days of nursing the first baby, as the nipple is soft and particularly prone to injury. At the end of lactation, especially if unduly prolonged, the associated debility undermines the general resistance of the patient.

When mastitis develops, the breast becomes swollen, red, and tender, and if the abscess is deep the presence of pus is indicated by oedema. Constitutional signs are well-marked. The condition has been confused with rapidly-growing carcinoma—mastitis carcinomatosis (see page 1980).

Treatment. As already emphasised, prophylactic treatment is of extreme importance and cases of mammary abscess are seldom encountered in efficient maternity homes.

When mastitis threatens lactation must be suspended, and the

breast emptied by means of a pump and "milking." Gentle and persistent massage will often be rewarded by the expression of thread-like clots from the mouths of obstructed ducts, with consequent relief of tenderness and tension. Fomentations or a belladonna plaster will then hasten resolution, and suckling is again resumed. When suppuration has occurred drainage is necessary.

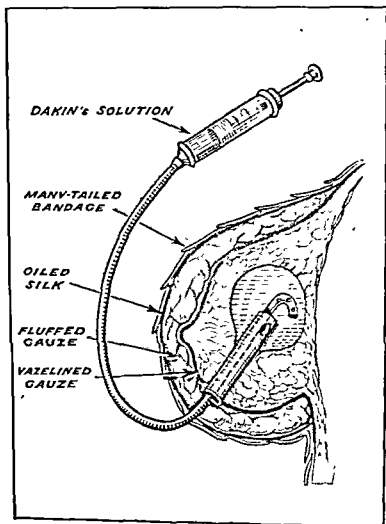


Fig 1033.—DRAINAGE OF A BREAST ABSCESS BY THE "CLOSED" METHOD.

Operation. A general anæsthetic is usually given, although gas and oxygen or evipan are adequate if facilities exist for their administration. The site of maximum softening or tenderness indicates the site for the incision, which radiates from the nipple. A finger is introduced so that the full extent of the abscess cavity is explored and any intervening septa are broken down. If necessary, counter-

drainage is provided, and a large tube is stitched in so as to secure dependent drainage.

An elaboration of the above simple drainage (1), and one which the author has found to yield excellent results, consists in passing a smaller rubber tube along the larger drainage-tube, so that the end of the inner tube lies in the abscess-cavity (fig. 1038). The breast is covered with lint on which vaseline is smeared, in order to protect it from possible excoriation arising from continual soaking with eusol.

A copious gauze dressing is applied, and kept in position by a many-tailed bandage, so arranged that the inner tube can be brought out

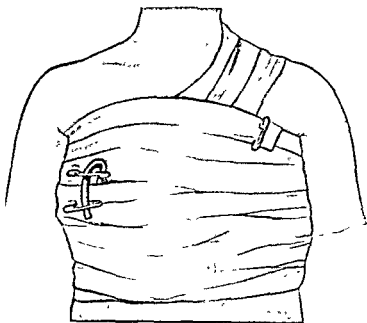


Fig. 1039.—THE SMALLER TUBE IS BROUGHT OUT THROUGH THE MANY-TAILED BANDAGE, SO THAT THE ABSCESS CAN BE IRRIGATED WITHOUT DISTURBING THE DRESSING. THE STERILE SWAB IS OMITTED FOR THE SAKE OF CLEARNESS.

through the tails of the bandage. The free end of the tube is wrapped in a sterile swab so as to maintain asepsis (fig. 1039). At four-hourly intervals, the cavity is irrigated with 15–20 cc. of eusol, the excess of which escapes into and is absorbed by the gauze dressing.

The gauze is changed once or twice a day, and towards the end of a week, according to local conditions, the tubes are removed, after which the inflammation usually subsides in a few days with the help of fomentations.

Breast abscesses treated by this "closed" method of drainage resolve more quickly than if drained in the usual manner, also the discomfort of frequent dressings and time required for such is materially diminished.

CHRONIC INFECTIVE MASTITIS

(i) *Non-specific.* Chronic abscess of the breast usually develops insidiously, and is probably due to low-grade hæmatogenous infection of a hæmatoma, which may have been produced by a long-forgotten injury. The condition is often impossible to distinguish from a scirrhous carcinoma, as the abscess cavity is obscured by surrounding œdema and fibrosis. Even trans-illumination may yield an indefinite shadow.

Treatment, as in all doubtful cases, consists in exploration. Excision is preferable to drainage as it ensures a more speedy convalescence.

(ii) *Specific.* Tuberculosis of the breast is either primary or secondary to spread from subjacent structures, such as the ribs. In primary cases both breasts are liable to be affected, and chronic abscesses break down to form ragged sinuses. The diagnosis is suggested by evidence of other tuberculous lesions and the bluish undermined edge of the sinus. Confirmation is obtained by bacteriological investigation or microscopical examination. Amputation is usually advisable.

Syphilis of the breast is very uncommon. Primary chancre of the nipple is practically obsolete, but in former days was occasionally seen in wet nurses. A transitory diffuse swelling is sometimes seen in the secondary stage. Gumma of the breast is a curiosity and resembles gummata in other soft tissues.

Actinomycosis occasionally invades the overlying breast as it spreads from the lung and pleura towards the surface.

CHRONIC INTERSTITIAL MASTITIS

The condition usually referred to as "chronic interstitial mastitis" presents itself in two more or less distinct types. The first type appears during the years of potential breast activity, and is relatively more common in unmarried women. This type is usually bilateral, which suggests some constitutional or metabolic cause, and it frequently yields to symptomatic treatment.

The second type occurs at or about the menopause and frequently progresses to cystic degeneration, or even to carcinoma. It is probably associated with some aberrance of involution. The initial change in the breast is hyperplasia of the epithelial cells and interstitial tissue.

The epithelial cells separate and collect in the alveoli which gradually become distended, and in some places papilliferous masses of cells project into the distended spaces. Cystic degeneration occurs (fig. 1040) and serous, brownish or greenish fluid may discharge from the nipple. Cysts form as a result of obstruction to the ducts by interstitial fibrosis or blockage by debris, and may be so extensive as to riddle the breast. The condition is considered by some authorities to be pre-cancerous, and microscopic sections of affected breast tissue sometimes reveal early carcinoma which clinically was unsuspected.



Fig. 1040.—MULTIPLE CYSTS IN CONNECTION WITH CHRONIC INTERSTITIAL MASTITIS. AN INTRA-CYSTIC PAPILLOMA IS PRESENT IN THE LARGEST CYST. (R.C.S., 1236, 1.)

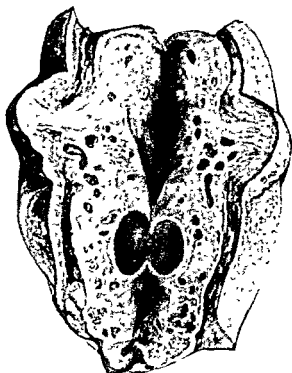


Fig. 1041.—CHRONIC INTERSTITIAL MASTITIS AFFECTING THE WHOLE BREAST, WITH MULTIPLE CYSTS. (R.C.S., 8100, 1.)

Clinical features. The first symptom in both types of chronic interstitial mastitis is usually neuralgic pain preceding and accompanying the period. Less commonly, the attention of the patient is drawn to the condition by the discovery of a lump or a "dirty" discharge from the nipple.

Examination reveals the following features :

(i) *Inspection.* The patient sits with the hands on the knees and both breasts exposed. General survey of the size and shape of the

breast may reveal enlargement of the whole breast or a local swelling. Slight retraction or occasionally elevation of the nipple occurs as a result of surrounding fibrosis.

(ii) Palpation. The patient should recline or lie down, so that it is not necessary to support the breasts synchronously with palpation. The opposite breast should first be palpated, as interstitial mastitis or some other unsuspected condition may be discovered, or if normal the consistency will form a basis of comparison when the affected breast is examined.

In the case of chronic interstitial mastitis an indefinite lump is felt which may apparently disappear when palpated with the "flat of the hand." If associated cysts are present, the swelling is correspondingly more definite and a cyst is manipulated so as to lie between the fingers and a rib when pressure gives a sensation of elasticity. Slight fixity to the skin is sometimes detected, especially if the swelling is subjected to pressure of clothes, but adherence to the pectoral fascia never occurs.

(iii) Glands. Axillary or supra-clavicular glands may be enlarged, in which case they are soft and possibly tender.

Treatment. If diagnosis is reasonably assured and the patient is under thirty-five years of age, palliative treatment is adopted. The breast is supported, counter-irritants are applied, e.g. belladonna plaster, ung. iodi., and small doses of potassium iodide given by mouth.

In older patients conservative measures are given a short trial, but if definite improvement does not occur, local excision is performed in order to allay anxiety and forestall possible malignant change. If the whole breast is affected amputation is necessary (fig. 1041), but the nipple should be preserved, and the muscles and axilla are undisturbed.

CYSTS

Cysts in the breast can be arbitrarily divided into those arising in connection with the ducts and alveoli (retention cysts) and cysts which occur in the stroma (interstitial cysts).

Retention cysts are frequently associated with discharge from the nipple (see page 1970) which occurs either spontaneously or on squeezing the breast so that the retention is momentarily overcome. Interstitial cysts, which have no connection with the secretory ducts, are unaccompanied by any discharge.

Retention Cysts. (i) Galactocele, which is due to obstruction of a milk duct, probably following contraction of a small scar resulting from injury inflicted by a hungry baby. A galactocele only occurs in a breast which is actively secreting milk. The resulting cyst is always beneath the areola, and sometimes attains the size of an orange. If untreated the wall becomes converted into a thick fibrous sac. These cysts are uncommon, but the history of the onset and the site of the cyst should suggest the diagnosis. Treatment consists in removal of the cyst.



Fig. 1042.—A MASSIVE CYSTADENOMA.
(After W. Mitchell Banks.)

(ii) Sub-areolar following a duct papilloma or carcinoma. In these cases a small cystic swelling appears near the nipple, and the history of a watery or blood-stained discharge suggests the diagnosis (see page 1979).

(iii) In association with chronic interstitial mastitis (see page 1975). Should the breast be riddled with cysts the condition is termed "polycystoma" (fig. 1041).

Interstitial Cysts. (i) Degeneration—a soft fibro-adenoma tends to undergo cystic degeneration, in which case the breast may be replaced by an enormous swelling, the cystic nature of which is to some extent demonstrable by trans-illumination. The term “sero-cystic disease of Brodie” still lingers in connection with this condition (fig. 1042). If neglected the skin is liable to atrophy at the site of maximal pressure, but a probe can be passed underneath the skin margin, which is one point in distinguishing this condition from a fungating new growth.

The breast, cyst and parent fibro-adenoma should all be removed.

Cystic degeneration is also prone to occur in sarcoma, and occasionally in cases of carcinoma.

(ii) Serous—which are lymphatic in nature, and are either single or multilocular. Their true nature is unlikely to be ascertained until after excision, but they are very rare.

(iii) Blood—which are due to incomplete absorption of serum, following an extravasation due to injury. The walls eventually become thick and fibrous and the cyst contains brown or yellow fluid and hæmatoidin crystals. The history may suggest the nature of the cyst, otherwise it is only recognised after excision.

(iv) Hydatid—occasionally occur in countries where hydatid disease is rife. As in cases of hydatid disease in other parts of the body, an examination of the blood reveals eosinophilia, and Casoni's intradermic test is positive. Treatment consists in removal of the cyst in its entirety.

NEW GROWTHS

New growths of the breast are classified as follows :

	<i>Innocent.</i>	<i>Malignant.</i>
I. Nipple. . . .	Papilloma	Epithelioma Melanoma
II. Ducts	Papilloma	Carcinoma (columnar-celled)
III. Gland	Adenoma	Carcinoma (spheroidal-celled) Mastitis carcinomatosis Encephaloid carcinoma Scirrhus carcinoma Atrophic scirrhus

- IV. Stroma . . . Fibroma Sarcoma
 Fibro-adenoma
 Lipoma

I. NIPPLE

(a) *Innocent.* A papilloma of the nipple resembles papillomata arising elsewhere. If allowed to grow, the tumour becomes pedunculated and the pedicle may eventually measure several inches.

(b) *Malignant.* Epithelioma of the nipple is uncommon, but has been confused with a primary chancre and early Paget's disease. Treatment consists in radical removal of the breast and axillary glands.

Melanoma of the nipple is a rare tumour and as in the case of melanomata elsewhere presents itself as a pigmented swelling which readily bleeds. Even after radical removal of the breast the prognosis is poor, owing to early and extensive dissemination.

II. DUCTS

(a) *Innocent.* Papilloma occurs most commonly in the fourth decade. The first sign is usually a watery discharge from the nipple. On examination, a small swelling caused by a retention cyst may be detected close to the nipple. Pressure on either side of the swelling sometimes succeeds in partially emptying the cyst.

Treatment consists, in the majority of cases, in local removal of the breast, as papillomata are sometimes multiple and tend to become malignant. If the patient is engaged or recently married and is therefore particularly anxious to avoid deformity, local resection of the suspected portion of the breast is performed in the hope that this will be sufficient.

(b) *Carcinoma* of a duct is presumably always secondary to a papilloma. The discharge, which was previously watery, becomes blood-stained and the tumour itself is sometimes palpable, although an accompanying cyst often obscures the tumour. Treatment consists in a radical amputation of the breast with the axillary glands.

III. GLAND

(a) *Innocent.* True adenoma, as opposed to fibro-adenoma, is exceedingly rare and is only diagnosed by microscopy after removal.

(b) *Malignant*. As in other situations, the malignancy of spheroidal-celled carcinoma depends to some extent on the age of the patient and the vascularity of the breast (e.g. pregnancy). Pathologically, as with carcinomata elsewhere, the greater the proportion of cellular tissue in comparison to stroma, the more malignant the tumour. Although carcinoma of the breast is described as occurring in various recognised forms, yet one type insensibly merges into another.

The following varieties are described in order of malignancy :

(i) *Mastitis carcinomatosa*. This condition occurs in association with pregnancy and lactation, and presents similar physical signs to those of acute infective mastitis. Thus the breast is enlarged and painful, while the skin is red and œdematous. Diagnosis is usually only made when the breast is incised with the object of locating pus, but instead of an abscess being found, the surgeon discovers that the breast is infiltrated by a solid, vascular tumour.

Palliative amputation may be performed if sufficient flaps can be fashioned, otherwise X-rays sometimes retard the rate of growth, but death usually occurs in about three months.

(ii) *Encephaloid carcinoma*. This type of carcinoma may be associated with pregnancy. It is a rapidly-growing tumour, but lacks the acute characteristics of the former variety. The breast soon becomes infiltrated by the growth, and then presents a prominent appearance, enlarged veins in the skin being obvious. Retraction of the nipple does not occur, but fixity to the underlying structures and involvement of the skin are early characteristics. Secondary involvement of the regional lymphatic glands speedily occurs. Encephaloid carcinoma in the early stages is liable to be confused with a soft fibro-adenoma (see page 1994), and at a later date distinction from a sarcoma (see page 1996) is sometimes difficult.

(iii) *Scirrhus carcinoma*. This is by far the commonest malignant tumour found in the breast. In an analysis of over 1000 cases L. B. Wevill (3) found that the first symptom in 55.9 per cent of cases was a lump associated with some degree of pain or discomfort. In 20.8 per cent of cases a lump was discovered which was entirely painless.

CLINICAL FEATURES

(a) *Inspection*. The tumour may be visible as a prominence of one portion of the breast. In about two-thirds of cases the tumour

is in the upper and outer quadrant while the next commonest situation is just below the nipple. Retraction or elevation of the nipple follows, and later puckering of the skin is seen (fig. 1043). *Peau d'orange* may follow lymphatic obstruction, and *cancer en cuirasse* occurs if the actual skin is invaded. In the late stages fungation of the tumour is followed by the appearance of a typical malignant ulcer.



Fig. 1043.—SCIRRHUS CARCINOMA OF THE BREAST, WITH PUCKERING OF THE SKIN AND PEAU D'ORANGE.

(b) Palpation. A definite hard swelling is palpable with the flat of the hand. Fixity to skin and pectoralis major muscle or chest wall occurs sooner or later. Nodules of growth are sometimes palpable in the skin.

(c) Trans-illumination. This very valuable method of investigation is unfortunately often ignored, possibly because clinicians do not realise how helpful it can be in doubtful cases. D. C. L. Fitzwilliams (4) has especially advocated trans-illumination as an aid to diagnosis. This method is best suited for pendulous breasts and for swellings in the lower two-thirds of the breast. A darkened room and a Cameron light (which remains cool) are necessary for the best effects. The patient sits opposite the surgeon and leans forward, and the light is placed beneath each breast in turn, the breast being pressed against the light by the surgeon's fingers. A normal breast is translucent, whereas a carcinoma shows a definite shadow. Chronic interstitial mastitis gives no shadow, and other swellings such as cysts or a chronic abscess are partly trans-illuminable, but the shadow is faint in comparison to the size of the swelling.

(d) Glands. Secondary deposits cause hard, painless enlargement of the axillary or supra-clavicular glands. Fixation occurs later, and adjacent structures are involved, e.g. axillary vein, causing œdema of the arm.

(e) General examination of the patient. Metastases may occur in widely scattered situations. Intra-thoracic growth is detected by physical examination or X-rays. The liver and the abdomen may be affected, especially if the primary growth is situated in the lower and inner quadrant of the breast. The opposite axillary glands are occasionally involved as a result of invasion of the skin, while osseous metastases are not uncommon, particularly in the spine or upper ends of the femur or humerus.

Differential Diagnosis. It should be an absolute rule to suspect every swelling in a breast of an adult female as malignant in nature unless definite proof is available to the contrary. In many instances the history or the physical signs disprove the possibility of malignancy. In other cases the diagnosis is probable or even certain, but there remains an intermediate group, the numbers of which vary with the experience (or sometimes ignorance!) of the individual clinician. It is these cases which temporising measures convert into tragedies, and it cannot be too strongly urged that exploration is essential in every doubtful case.

Almost any localised swelling may be mistaken for a scirrhus carcinoma, especially if the breast is fat and the swelling deep. However, in many cases, the diagnosis of non-malignant swellings can be made with confidence; thus a patch of uncomplicated mastitis cannot be palpated with the flat of the hand, and a fibro-adenoma is smooth in outline and can be moved freely in the breast substance.

There are three conditions which may be extremely difficult or even impossible to distinguish from a scirrhus carcinoma :

(a) *Cystic mastitis*—the cyst or cysts form a definite swelling which is obscured by surrounding fibrosis, so that their consistency is difficult to ascertain. Also the cysts are frequently so tense that they feel hard rather than elastic. If the cyst can be manipulated so that it is supported by a rib then its elastic consistency can often be recognised. Trans-illumination is often very helpful.

(b) *Chronic abscess*—which usually occurs insidiously, and forms an indefinite lump in the breast. The pus is walled in by fibrous and

granulation tissue and is further obscured by surrounding œdema. Tenderness is slight, and constitutional symptoms are usually absent. A shadow is seen on trans-illumination, but is less definite than that of a carcinoma of equal size.

(c) *Fat necrosis*—this rare condition is due to liquefaction and saponification of fat as a result of trauma. Surrounding fibrosis and calcification result in a swelling which is indistinguishable from

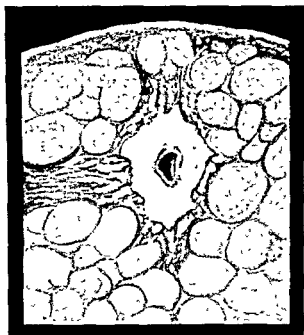


Fig. 1044.—FAT NECROSIS OF THE BREAST.
(After G. Hadfield.)



Fig. 1045.—A TYPICAL SCIRRHUS CARCINOMA OF THE BREAST, WITH RETRACTION OF THE NIPPLE.
(R.C.S., 8183, 1.)

carcinoma (fig. 1044), particularly as it is sometimes adherent to the skin. Fat necrosis has also been recorded as occurring after saline infusion into the breast.

As already emphasised, the true nature of every doubtful swelling must be revealed by exploration, and permission must be obtained prior to the operation for radical removal of the breast should this be advisable. Exploration is carried out by removal of an ellipse of breast which includes the swelling. This is preferable to incising the swelling *in situ* as thereby dissemination is favoured, and whatever the nature of the swelling may be it is better removed. After excision the swelling is incised and in the majority of cases a confident diagnosis is possible. Should it be a scirrhous carcinoma the growth is firm in

consistency, the cut surface is greyish, and owing to retraction of fibrous tissue becomes concave (fig. 1045). Also, the tumour ramifies among the normal breast tissue in a manner which justifies its name, culled from the signs of the Zodiac, of "Cancer," the crab. A small percentage of cases are of doubtful nature and it is in these cases that the preparation of frozen sections is very valuable. This method is extensively used in America, and the pathologist is usually able to give a definite diagnosis within five minutes.

Unless the swelling is proved to be non-malignant, the instruments, gloves and towels are changed and a radical removal of the breast and glands is performed.

Treatment. The question of treatment by radium is discussed on page 1599, and until more data are available and more time has elapsed it is unwise to dogmatise regarding the relative merits of radical operation and radio-therapy. Radium has certainly widened the scope of breast surgery and cases which formerly would have been considered as "inoperable" are now benefited by radio-therapy. Thus patients with associated conditions such as cardiac lesions or advanced phthisis are suitable for the insertion of radium, whereas a severe operation is out of the question. Also advanced cases, in which the growth is fixed to the chest wall or extensively invades the skin, are sometimes benefited considerably by radio-therapy.

RADICAL OPERATION

The radical operation entails removal of the breast, a portion of the overlying skin, the pectoralis major (sternal part) and pectoralis minor muscles, and deep fascia from the clavicle to epigastrium, and from the mid-line to the latissimus dorsi (the actual area of deep fascia to be excised varies somewhat with the site of the tumour, and includes all within a five-inch radius). In addition, the costo-coracoid membrane, axillary fat, glands and cellular tissue are removed. Some surgeons include the supra-clavicular glands, but thorough removal may prolong the operation unduly. Amputation of the breast is one of the very few operations in which fat is welcome, as it leaves a wider margin of safety.

The patient lies with the affected side near the edge of the table, and a small sand-bag is placed under the scapula. An assistant sits by the patient's head, holding the arm in a position of right-angled abduction.

The incision commences close to the insertion of the pectoralis

major muscle, crosses the base of the axilla and then turns upwards to meet the anterior border of the pectoralis major. On approaching the tumour it bifurcates and forms an ellipse in the centre of which the tumour is situated. The ellipse also includes the nipple and at least two inches of skin on either side of the tumour. From the lower end of this ellipse the incision is then carried downwards on to the epigastrium as far as necessary. Some surgeons prefer to encircle the breast with an incision, and then extend it upwards to the axilla and downwards to the epigastrium.

The upper part of the incision is first made, and flaps are turned aside so as to expose the groove between the sternal and clavicular portions of the pectoralis major muscle. These two portions of muscle are separated and the sternal part is divided at its insertion into the outer lip of the bicipital groove. The pectoralis minor muscle is thus exposed and is severed close to the coracoid process. The second and third parts of the axillary artery are now revealed, and the axilla is opened up. All fat, glands and cellular tissue are removed from the posterior and inner axillary walls, special care being taken to preserve the long subscapular nerve, passing downwards on the subscapular muscle to the latissimus dorsi, and the nerve of Bell, which lies on and supplies the serratus magnus muscle. Subscapular glands are frequently enlarged, and removal is facilitated if the subscapular vessels are first ligatured. The axilla is protected by a warm sponge and the outer flap is now turned back, half the subcutaneous fat being dissected up with the skin for the purpose of nutrition, and the rest being left on the deep fascia so that portions of the deep fascia will not be inadvertently retained on the skin flap. The intercosto-humeral nerve is necessarily divided as the skin flap is turned downwards, and a post-operative patch of anaesthesia usually results and persists for a few months. On arriving at the anterior border of the latissimus dorsi the incision is deepened to divide the deep fascia, which is dissected inwards with superficial fibres from the digitations of the serratus magnus and external oblique muscles.

The exposed chest wall is protected with warm saline packs and the inner flap is now dissected through the mid-fatty plane at least as far inwards as the middle line, and upwards to the clavicle. The deep fascia is incised and dissected towards the breast, and the sternal and costal origins of the pectoralis major are divided as they become exposed. If the sternal part of the pectoralis muscle is turned downwards as it is reflected from the ribs the perforating branches of the internal mammary artery can be secured before they are divided ;

otherwise they are liable to retract through the intercostal spaces, with risk of hæmothorax, or injury to the pleura in efforts to arrest hæmorrhage.

The clavicular portion of the pectoralis major muscle is retracted upwards over the clavicle. The costo-coracoid membrane is thus exposed and dissected from the underlying axillary vessels; the thoracic axis artery and vein and the anterior thoracic nerves are divided, but the cephalic vein should be preserved if possible. This dissection ends at the junction of the first and second parts of the axillary artery, i.e. where the operation originally commenced.

All that now remains is to divide the origin of the pectoralis minor muscle from the third, fourth and fifth ribs, and, with a few touches of the knife, the breast and attached structures are removed (fig. 1046).

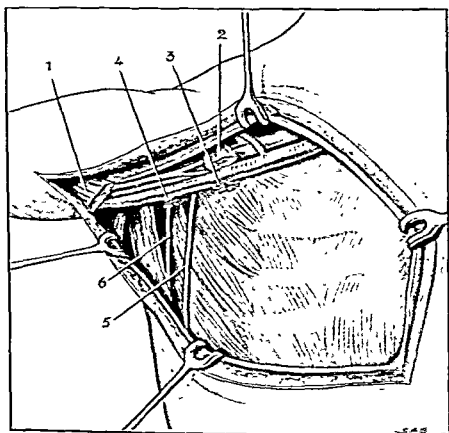


Fig. 1046.—DIAGRAMMATIC REPRESENTATION OF OPERATION FIELD AFTER RADICAL REMOVAL OF THE BREAST.

1. Divided sternal portion of pectoralis major muscle.
2. Divided pectoralis minor muscle at its insertion into the coracoid process.
3. Thoracic axis vessels.
4. Subscapular vessels.
5. Nerve of Bell lying on the serratus magnus muscle.
6. Middle or long subscapular nerve.

Complete hæmostasis is secured, a stab wound for drainage is made through the posterior axillary fold, and the incision is closed, tension stitches being inserted if necessary. A voluminous dressing is firmly bandaged in position, and the patient propped up in bed with the affected arm abducted on a pillow so that subsequent contraction of the scar will not limit abduction. The tube is removed in thirty-six hours, and early movements are encouraged.

COMPLICATIONS

Shock is surprisingly slight in proportion to the severity and extent of the operation. Nevertheless, hot packs or towels should be used freely in order to cover exposed areas, and bleeding points are secured without delay.

Lymphorrhœa. Occasionally, for no apparent reason, a considerable amount of blood-stained lymph collects under the flaps, due to division of lymphatics. The lymph tends to recur for several days, and is evacuated by inserting sinus forceps through the drainage wound, or at some appropriate point along the suture line. Firm bandaging or strapping assists in approximating the flaps to the chest wall.

Infection of flaps is liable to recur if flaps are thin and under tension, especially if their vitality is lowered by lack of protection during the operation. If sloughing or retraction occurs, skin-grafting may be necessary.

Limitation of movement is most commonly due to contraction of the scar, especially if the incision is made along the anterior axillary margin. To obviate excessive contraction of the scar the arm is kept abducted during healing of the wound, but the degree of abduction must not be sufficient to cause undue tension on the suture line. Gradually increasing efforts at abduction after the wound has healed are usually rewarded by adequate restoration of movement.

Brawny arm is either due to pressure of scar tissue on the axillary vein and lymphatics, or to carcinomatous infiltration of lymphatics and implication of the axillary vein by malignant deposits.

Mechanical obstruction appears within a few weeks of convalescence, and the arm does not assume such a massive size as in malignant obstruction. Also the condition frequently improves, although some

degree of swelling, especially after use, is liable to persist. Treatment consists in massage, elevation and support as by a crêpe bandage. Sampson Handley's operation of lymphangioplasty may be considered in persistent cases. It consists in the introduction of subcutaneous silk threads from the forearm and arm to the scapular region, so as to provide new channels for the return of lymph. A special probe and forceps are necessary and rigid asepsis is essential, otherwise the infection readily spreads along the threads. Elevation of the arm is advisable for some weeks after the operation. Few surgeons find that the procedure gives permanent relief.

Malignant obstruction may progress to such a degree that the arm is thicker than the patient's thigh. It is steadily progressive and causes intense discomfort and no little pain. In most cases the presence of secondary deposits elsewhere than in the axilla soon terminate the unfortunate patient's misery. Should an exhaustive examination fail to reveal any other metastases, then Berger's operation (interscapulo-thoracic amputation) should be considered, provided the general condition of the patient is adequate. If the nerves in the axilla are involved by growth, then the intense pain which results is an additional reason for this extensive operation.

PROGNOSIS

The prognosis in scirrhous carcinoma, as in carcinomata elsewhere, depends largely on the stage at which the patient presents herself for treatment. Hopelessly late cases are still all too common, and are occasionally the result of misguided advice to temporise on the part of the practitioner, which the patient is only too willing to accept. More commonly the dread of being told that a lump is a cancer deters the patient from seeking advice; so she hugs the secret to her breast and tries to forget her forebodings.

Invasion of lymphatic glands is of grave moment, and the figures quoted by Halsted in 1911 still approximate to the truth. He stated that in the absence of invasion of the axillary glands the prospect of cure was two cases in three, but that recurrence occurred in three cases out of four if glands were affected. This disparity does not depend upon actual invasion of the glands in the axilla, as these lend themselves to removal, but axillary infection is an index to the extent of dissemination in other directions, notably parasternal or supra-clavicular.

Another factor in prognosis is the age of the patient. A scirrhous carcinoma grows much more rapidly in a potentially active breast than it does after the menopause. Should pregnancy occur, then the resultant hyperæmia nourishes the carcinoma cells and the growth may become almost encephaloid in nature.

The site of the tumour influences the rate of dissemination in various directions. Thus a growth near the middle line is liable to give rise to early mediastinal deposits, and a carcinoma in the lower and inner quadrant is apt to spread to the liver and peritoneal cavity. Fixity to the chest wall occurs at an early date if the lower and outer

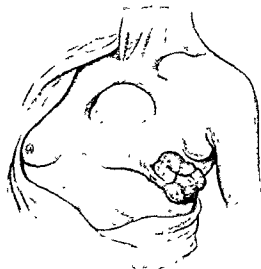


Fig. 1047.—RECURRENT AFTER REMOVAL OF THE BREAST. A FUNGATING ULCER HAS APPEARED IN THE SCAR, WITH SECONDARY DEPOSITS IN THE STERNUM, AXILLA AND SUPRA-CLAVICULAR REGION.

quadrant is affected, as in this situation the chest wall is not protected by the pectoralis major, and the breast lies directly upon the serratus magnus muscle.

Recent investigation (6) of a series of cases from different sources indicates that the "crude" survival-rate five years after operation is about 36 per cent. Allowance must be made for deaths due to accident or intercurrent disease, and when this factor is taken into account the net survival-rate is approximately 40 per cent.

RECURRENCE (fig. 1047)

Local. Recurrence in the neighbourhood of the scar is much less common at the present time than in former years, owing to a wider

removal of skin and fascia. Prophylactic applications of X-rays or radium in Columbia paste also act as deterrents to local recurrence.

Any nodule which appears can either be excised locally or destroyed by means of radium.

Parasternal. The glands along the internal mammary artery are one of the commonest sites for recurrence. It is possible to expose and remove these glands by turning back, in each intercostal space, a flap consisting of the anterior intercostal membrane and the internal intercostal muscle. However, most surgeons endeavour to destroy any secondary deposits on the parasternal glands by means of radium needles inserted beneath the intercostal muscles.

The upper six spaces should so be treated.

Supra-clavicular. The first indication of recurrence in the supra-clavicular region is the appearance of a firm gland at the lower and inner angle of the posterior triangle. Unless the gland or glands are fixed, those in the posterior triangle and those on the carotid sheath should be completely excised, just as the glands in the anterior triangle are excised in cases of carcinoma of the tongue. Exposure is obtained by two incisions, one along the posterior border of the sterno-mastoid muscle from the mastoid process to the clavicle, and a second one from the lower end of the first incision to the anterior border of the trapezius. The flap of skin and platysma is turned backwards, and the spinal accessory nerve is identified as it emerges from the posterior border of the sterno-mastoid at the junction of its upper third and lower two-thirds. The sterno-mastoid muscle is retracted inwards so as to expose the carotid sheath, which is divided with the omo-hyoid so as to expose the vessels. The fascia is dissected outwards with the glands as far as the anterior border of the trapezius muscle, the branches from the third and fourth cervical nerves to the trapezius being spared if possible. Subsequent radio-therapy by means of needles of a Columbia paste collar discourages subsequent recurrence.

In the case of fixed supra-clavicular glands radium needles or deep X-rays retard the progress of the disease.

Mediastinal. Secondary deposits in the mediastinum either follow invasion of the parasternal glands or occur independently, especially if prophylactic radium has been inserted in the intercostal spaces. Cough and breathlessness are early symptoms, and pleural effusion further hampers pulmonary expansion. Clear or blood-stained

fluid may be aspirated, but any relief so gained is very temporary. An X-ray sometimes reveals mediastinal deposits before they are detectable clinically. Deep X-ray therapy occasionally results in some amelioration of symptoms.

Bones. Secondary deposits in bones are more common than with any other form of carcinoma. Excluding direct invasion of the ribs or sternum, the upper end of the humerus, the dorsal or lumbar vertebræ and the neck of the femur are the commonest sites.

The patient complains of local pain, which is ascribed to neuritis, rheumatism, or some similar cause. Long bones are liable to spontaneous fracture, or in the case of the spine sudden collapse sometimes occurs and paraplegia usually results. An X-ray shows a typical



Fig. 1048.—SECONDARY DEPOSIT IN THE NECK OF THE FEMUR, FOLLOWING A SCIRRHUS CARCINOMA OF THE BREAST.

osteolytic deposit, the bone being destroyed with little or no reaction fig. 1048).

If fracture results, union will occur should the patient survive for a sufficient interval. Deep X-ray therapy sometimes results in complete reformation of the bone.

Abdomen. As already stated, the liver or peritoneal cavity are especially liable to invasion if the primary tumour occurs in the lower and inner quadrant of the breast. As with other forms of abdominal carcinoma, trans-cœlomic implantation may result in large secondary ovarian tumours (Krukenberg's tumour).

POST-OPERATIVE INVESTIGATION

It is the duty of the surgeon periodically to examine all cases so that the patient may be reassured if all goes well, or in the event of recurrence to prescribe such treatment as is applicable.

The following indicates a routine suitable for this periodic examination :

History. This includes weight and questions regarding the general health, especially of any unexplainable cough. Also symptoms which the patient may ascribe to rheumatism, lumbago or sciatica, which might indicate a secondary deposit in the humerus, spine or femur.

Examination. The operation field is examined for nodules. The axillæ, supra-clavicular glands and opposite breast are palpated. The hand and arm are examined for œdema. The chest is percussed and auscultated and the abdomen examined for evidence of enlarged liver or ascites. If considered necessary, a rectal or vaginal examination is made in order to detect pelvic or ovarian metastases.

Radiograph. In doubtful cases a radiographic examination is made of the chest, or of any bones suspected of harbouring metastases.

Atrophic scirrhus occurs in elderly females. It is extremely slow in growth, and many years may elapse before fungation occurs. The breast often becomes puckered, owing to extensive fibrosis. Unless the physical or mental condition of the patient is a contra-indication, treatment is conducted as for a scirrhus carcinoma.

Carcinoma of the male breast accounts for about 1 per cent of cases. As the tumour is not obscured by fat, early discovery and diagnosis is the rule, but the prognosis appears to be less favourable than in cases occurring in females.

INNOCENT TUMOURS OF THE STROMA

Hard *fibro-adenomata* are common tumours which probably arise between the ages of fifteen and twenty, but as they cause only trivial symptoms, they may be discovered at a later period. The commonest type is the intra-canalicular, in which ingrowths of fibrous tissue protrude into a duct, the epithelium of which atrophies. Continuous invasion of the duct gradually obliterates the epithelium-covered spaces, until the tumour becomes practically a fibroma.

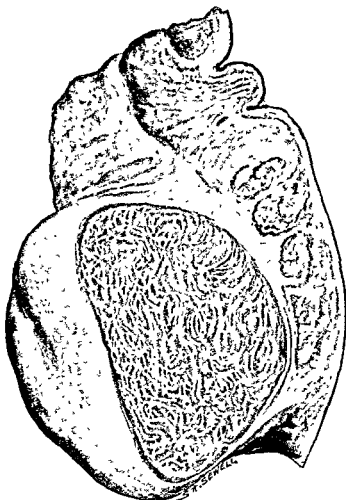


Fig. 1049.—A LARGE HARD FIBRO-ADENOMA, SHOWING TYPICAL WHORLED APPEARANCE AND WELL-MARKED ENCAPSULATION.
(R.O.S., 1624, 1.)

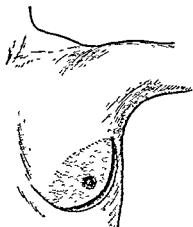


Fig. 1050.—GAILLARD THOMAS'S INCISION. THE DOTTED AREA INDICATES DEEP SURFACE OF THE BREAST WHICH CAN BE READILY EXPOSED.

The less common type is the peri-canalicular, in which fibrous tissue grows around the duct and acini without destroying the epithelium. The two types are only distinguishable on microscopic section.

Clinically the tumour presents itself as a firm, painless swelling, characteristically freely movable in the breast substance (fig. 1049). As the tumour enlarges it tends to become lobulated, and in long-standing cases chronic interstitial mastitis develops in the adjacent portion of the breast. Several hard fibro-adenomata may be present in the same breast, or the opposite side is sometimes similarly affected.

The tumour is liable to be mistaken for a cyst associated with chronic mastitis, but if the swelling can be steadied on a rib the elastic consistency of a cyst is usually demonstrable. In nearly all cases the freedom of mobility, smooth outline, and age incidence are sufficient to distinguish a fibro-adenoma from a carcinoma.

Although hard fibro-adenomata are unlikely to undergo secondary changes, removal is indicated in order to relieve the patient of worry. Also, most patients develop neuralgia or pain at the menstrual periods when they are aware of a lump in the breast.

Unless the tumour is situated in the upper and inner third of the breast, removal is best accomplished by Gaillard Thomas's incision (fig. 1050). This incision is made below and to the outer side between the breast and the chest wall, and is deepened so that the breast can be raised from the pectoralis major muscle. No large vessels enter the deep surface of the breast and the breast is easily separated and everted. The tumour is removed by an incision which radiates from the nipple, and thus avoids severing ducts. As a rule enucleation is readily accomplished, and the resulting cavity is obliterated by catgut sutures. A small drain is inserted and the skin united with silkworm-gut. The resultant scar is practically invisible.

Soft fibro-adenomata are comparatively rare tumours. They occur between the ages of thirty and forty-five and grow with comparative rapidity. Microscopically a soft fibro-adenoma contains fusiform cells and little mature fibrous tissue. Small spaces corresponding to myxomatous degeneration are commonly seen and these may eventually unite to form a cystadenoma. As in the case of tumours largely composed of fibrous tissue in other situations, notably muscle sheaths and the gums (fibrous epulis), the margin between rapidly-growing fibroblasts and actual spindle-celled sarcoma is very narrow, and is liable to be overstepped.

Clinically a soft fibro-adenoma grows with moderate rapidity and

may become as large as an orange in a few months. The swelling causes obvious fulness in the breast, but dilated veins are not conspicuous. The tumour is soft in consistency, and in some places the surface can be distinctly palpated from the breast tissue. If ignored cystic degeneration is liable to occur, in which case the tumour becomes massive (sero-cystic disease of Brodie, fig. 1015). Fungation through



Fig. 1051.—CYSTADENOMA. THE SKIN BENEATH THE NIPPLE HAS UNDERGONE PRESSURE ATROPHY, AND THE TUMOUR IS PROTRUDING. THE REMAINS OF THE SOFT FIBRO-ADENOMA FROM WHICH THE CYST AROSE ARE SEEN BELOW.

(R.C.S., 3160, 1.)

the skin was occasionally seen in former days, and the condition was distinguished from a fungating carcinoma in that a probe could be inserted between the skin margin and the tumour.

Nowadays the possibility of a patient harbouring a massive tumour until fungation occurs is very remote.

Treatment consists in local excision of the fibro-adenoma in the early stages. When the tumour has become so large as to overshadow the breast, then amputation is preferable. Should there be any doubt as to the innocency of the tumour a radical operation combined with removal of the axillary contents is essential.

Lipoma of the breast is an uncommon tumour, and its consistency resembles that of the breast. The patient first notices some fulness (fig. 1052), and unless the edge of the lipoma can be felt the diagnosis is doubtful. The tumour can usually be removed through a sub-mammary incision.

MALIGNANT TUMOURS OF THE STROMA

Sarcoma of the breast is uncommon, and accounts for less than 1 per cent of malignant tumours. Probably at least half the cases

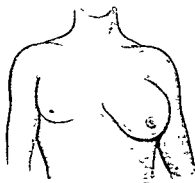


Fig 1052.—A PROMINENT BREAST DUE TO A SUBMAMMARY LIPOMA.
(After K. Markoh.)

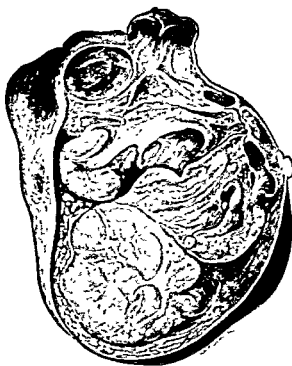


Fig. 1053.—SARCOMA OF THE BREAST. THE TUMOUR HAS FUNGATED THROUGH THE SKIN.
(R.C.S., 5155, 1.)

are due to secondary changes in a soft fibro-adenoma, and it is sometimes difficult even for an expert microscopist to be dogmatic as to whether a given section is a rapidly-growing fibro-adenoma or a spindle-celled sarcoma of low malignancy.

Clinically, the history is sometimes suggestive in that the patient may have noticed a swelling for months or years which has recently enlarged rapidly. On inspection, a typical sarcoma forms a prominent swelling over which dilated veins are obvious. Retraction of the nipple and puckering of the skin are absent. Palpation suggests that

the breast is replaced by the tumour, which often exhibits areas of unequal consistency due to cystic degeneration or hæmorrhagic extravasation. Only in the late stages does the skin become adherent or fungation occur (fig. 1053). Involvement of the axillary glands is also a late manifestation.

Treatment consists in radical amputation, including the axillary contents. Although undoubted cases of early sarcoma have enjoyed apparent cure by only local removal, the more extensive operation should be performed, and reinforced with subsequent deep X-ray therapy.

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PART IX
THORAX

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by
R. SLEIGH JOHNSON

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SECTION 1
MEDICAL CONDITIONS

by
R. SLEIGH JOHNSON

CHAPTER I
POST-OPERATIVE CHEST COMPLICATIONS

THE introduction of asepsis into operative surgery provided a landmark of safety without equal in widening its field of application, in that at a single step the factor of local septic infection was revolutionised and its incidence reduced to a minimum. It is comparatively more recently, however, that the problem of post-operative thoracic complications has been similarly attacked. Such progress as has been attained in this regard must be largely placed to the credit of modern refinements of anæsthesia, which have been steadily evolved *pari passu* with the advance of surgical technique.

While by these means the incidence of chest complications has been progressively lowered, the liability to such sequelæ still remains of sufficient frequency and importance to merit their separate consideration in a text-book of surgery. Great variation is, of course, found in the figures of various observers, but it is generally agreed that if a large series be taken the incidence of chest complications in one form or other after abdominal section is often as high as 10 per cent, while they are still the direct cause of fatality in about 0·5 per cent of all operations and in over 1 per cent of laparotomies. A short review of the more important varieties is therefore given in the present section. Moreover, the greater care now bestowed on pre- and post-operative treatment, together with a critical study of the possible causes of respiratory complications, has led not only to a reduction in their incidence but also to the evolution of suitable methods of combating them when they nevertheless arise.

A simple classification of such complications may be made on an anatomical basis, but it must be remembered that many of them are but different stages of the same infective process and are, therefore, so

interrelated and combined as to render their consideration as strictly separate entities unfeasible. Many, moreover, have ætiological factors in common, and principles of prevention, therefore, apply equally and may to some extent be considered together.

POST-OPERATIVE CHEST COMPLICATIONS

- I. *Acute tracheo-bronchitis.*
 - (a) Catarrhal bronchitis of upper tubes.
 - (b) Catarrhal bronchiolitis or capillary bronchitis.
 - (c) Acute septic or suppurative bronchitis.
- II. *Pulmonary collapse.*
 - (a) Partial basal collapse.
 - (b) Massive lobar collapse.
- III. *Pulmonary infarction or embolism.*
- IV. *Pneumonia.*
 - (a) True lobar pneumonia.
 - (b) Secondary broncho-pneumonia.
- V. *Pulmonary suppuration.*
 - (a) Diffuse—acute septic pneumonitis.
 - (b) Localised—pulmonary abscess.
- VI. *Gangrene of lung.*
- VII. *Pleurisy.*
 - (a) Fibrinous.
 - (b) Empyema.
- VIII. *Affections of the mediastinum.*
- IX. *Late pulmonary effects.*
 - (a) Exacerbation of previous disease, e.g. pulmonary tuberculosis.
 - (b) Pulmonary fibrosis and bronchiectasis.
- X. *Post-operative cardio-vascular affections.*
 - (a) Effects of shock and vasomotor paresis.
 - (b) Myocardial dilatation and failure.

Predisposing factors. At this stage, before attempting a detailed discussion of each complication, it may be helpful to review in a general way the main factors which are known to predispose to their several occurrence.

Regarded first from the standpoint of the patient, age is of significance. As with pulmonary affections in general, so with post-operative sequelæ the extremes of life are most disposed to suffer, infancy and especially old age showing a relatively heavier incidence. The presence of previous known chest disease, whether cardiac or respiratory, or of intemperate habits, is similarly a predisposing factor, and partly for these reasons the male sex is the more commonly affected, the incidence of chest complications being approximately twice as frequent as in women. Obesity in either sex and at any age likewise definitely predisposes to thoracic events.

A further factor intimately affecting the likelihood and the type of respiratory complication is the nature of the operation performed. Thus, abdominal operations are greatly more prone to be followed by chest trouble than are operations on the extremities, as in orthopædic work. King (1) in a statistical review finds that such complications occur more than twelve times as frequently after laparotomy as after operations in the non-abdominal group. The zone of the abdomen opened is of equal significance, for basal collapse and broncho-pneumonia are most often seen after interference high up in the neighbourhood of the diaphragm, operative procedures on the stomach, duodenum and gall-bladder being especially concerned. Section of the lower abdomen, as for appendicectomy or operation on the bowel, carries considerably less thoracic risk. Pelvic operations, especially those of a gynæcological nature, show no undue tendency to subsequent lung involvement proper, but are specially liable to be followed by pulmonary embolism. Not only the site, but also the duration of the operation and the amount of handling of viscera or pulling of tissues involved are similarly of the greatest significance. Chest complications are, for example, considerably higher in most hands after such a major resection as gastrectomy than after simple gastric or duodenal suture. A long and difficult gall-bladder removal is another frequent example. Sepsis, i.e. peritonitis calling for insertion of a drainage-tube, also greatly increases the incidence. Operations on the upper air-passages form a group of their own in their especial liability to downward spread of infection. The choice and mode of administration of anæsthesia, considered in detail later, constitute an outstanding aspect of the problem, whilst general considerations of pre- and post-operative care are of scarcely less importance.

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I. ACUTE TRACHEO-BRONCHITIS

(a) *Catarrhal bronchitis of the larger tubes*

Predisposing factors. Factors leading to the intercurrent of bronchitis include any undue chilling of the patient, whether in the theatre itself or in transit to the ward, the presence at the time of operation of a cold, sore throat, or bronchial catarrh, and the liberal use of ether anaesthesia, especially in excessive concentration.

Acute bronchitis, usually associated with tracheitis, becomes apparent as a rule within 48 hours of operation, and is shown by malaise, slight fever and general discomfort and by paroxysmal cough, at first dry and irritating and accompanied by soreness or pain in the region of the larynx and beneath the sternum. Some degree of dyspnoea may also be present. If the infection is confined to the larger tubes, rhonchi and sibili are heard over the upper part of the chest, but the percussion note and breath sounds are unaltered and the colour is good. With involvement of the larynx there is hoarseness or aphonia. Later, the cough loosens, with the production of frothy mucoid or mucopurulent sputum. With treatment, the fever and signs should subside within a week or so. The volume of sputum and the degree of its purulent element vary according to the intensity of the infection and the extent of its downward spread.

Treatment of Bronchitis. The treatment of acute catarrhal bronchitis without pulmonary involvement is in the main symptomatic. The early irritating cough is eased by a warm though well-ventilated room between 60° and 65° F., in which if breathing is tight the air may be kept moistened by a steam-kettle, with the addition of creosote or tr. benzoini co. 1 dr. to 1 pt. It is especially important to maintain the room temperature at night. Warmth to the chest by antiphlogistine or a light poultice or gamgee jacket is comforting, with gentle inunction of a counter-irritant such as lin. camph. or iodox and methyl salicylate. Hot bland drinks are helpful, together with opening of the bowels if the surgical condition will allow. During the early stage the tight cough will be eased by a sedative diaphoretic mixture given 4- or 6-hourly, containing, for example, vin. ipecac. and tr. camph. co. āā 10 minims, pot. citratis 20 grs. and liq. ammon. acet. 2 dr. with aq. camph. to 1 oz. The time-honoured Gee's linctus, comprising equal parts of tr. camph. co., oxymel of squills and syrup of tolu, 1 dr. 6-hourly, is

also valuable. Mild hypnotics, avoiding morphia, may be needed to promote sleep. Later, expectoration may be helped by a stimulating mixture containing, say, ammon. carb. 5 grs., pot. iodidi 3 grs., syr. scillæ 15 minims and inf. senagæ to 1 oz. 6-hourly. Simple alkalis such as sod. bicarb. 15 grs., with sod. chloride 5 grs., given with hot water, also greatly aid in loosening secretion and promoting its expulsion. Care must be taken to encourage deep breathing and to avoid any constriction of the chest, while any attempt to hurry convalescence unduly should be avoided.

(b) Catarrhal bronchitis of the smaller tubes or capillary bronchitis

The distinction between a capillary bronchitis or bronchiolitis and a broncho-pneumonia is one merely of degree and often impossible to make on clinical grounds with any exactitude. Following on a severe catarrhal bronchitis of the upper chest, within a few hours or days the degree of illness becomes more marked, fever is generally though not invariably higher, the colour alters, breathing becomes rapid and shallow, and over the lower lobes on both sides there appear copious fine and medium râles obscuring the breath sounds. The right side of the heart may be embarrassed. Sputum becomes muco-purulent, frothy, and copious, provided that the strength of the patient remains adequate to expel it. The smaller the size of the affected bronchi the more intimate does the admixture with air become. Treatment of this condition is considered under that of broncho-pneumonia with which it merges.

(c) Acute septic or suppurative bronchitis

Acute suppurative bronchitis after operation is much less common than catarrhal bronchitis and is usually secondary to the inhalation of infective secretions from the throat or of liquid ether. Its onset is more rapid, usually within 12 to 24 hours of operation, and the illness is correspondingly more severe and prolonged. An intense diffuse inflammatory process is set up in the larger and medium-sized bronchi, which is very prone to extend rapidly to the smaller air-passages and alveoli, producing patchy areas of collapse and broncho-pneumonic consolidation. Shivering and high fever develop with cyanosis and dyspnoea, while the breath sounds are weak, with diffuse bubbling râles over the chest, though the percussion note remains unimpaired. At first scanty and tenacious, the sputum rapidly becomes abundant or even profuse, up to a pint or more in the 24 hours, of thin

consistency and intensely purulent in nature, with perhaps streaks of bright blood. A foetid odour may be present. The prognosis is serious and a fatal broncho-pneumonia may ensue.

Treatment of Acute Suppurative Bronchitis. Treatment of acute suppurative bronchitis after operation under general anæsthesia is again, in the main, symptomatic and stimulant, i.e. to support the heart muscle, to aid removal of secretions, and to combat the severity of the infection. Abundant fluids should be given by mouth. Brandy, atropine and strychnine are valuable with other cardiac stimulants such as camphor if needed. Inhalation of oxygen sometimes lessens the cyanosis but is disappointing because of the intense generalised bronchial engorgement. Inhalations and the giving of alkaline expectorants should also be tried. Much benefit has recently been obtained by repeated bronchoscopic aspiration where the sputum is profuse and highly purulent, and where the direct irritant action of inhaled material has been a factor, such as the accidental entrance of liquid ether or chloroform. Lavage of the bronchi should not be used because of the general nature and extent of the infection and the danger of spread thereby to yet further areas of the lungs. If a bronchoscope is not available, much may be done to diminish the risk of the patient's being suffocated by his own secretions, by the simple expedient of passing an endotracheal catheter and aspirating the purulent sputum with an electric suction pump. In extreme cases a small cannula may be inserted directly into the trachea, through which a rubber catheter is passed and continuous suction applied. Thus sputum may be got rid of, which the patient is unable to expel through his own efforts owing to general prostration and complete loss of ciliary action by acute inflammatory changes in the mucosa.

II. POST-OPERATIVE PULMONARY COLLAPSE

Formerly every type of post-operative pulmonary complication was included under the single term of "ether pneumonia" without discrimination or proper concept of its nature and mode of production. It is not sufficiently realised how commonly physical signs, if searched for, are to be found at the lung bases after operations upon the upper abdomen, even in the absence of any respiratory symptoms. In the great majority of cases they indicate not pneumonic consolidation, but a partial collapse of one or both lung bases, resulting chiefly although

not solely from a temporary inhibition of diaphragmatic movement, and consequent absorption of air from the subjacent alveoli. A number of other factors may combine to assist this deflation of the lung, as will be enumerated later. Most patients, for example, after cholecystectomy will be found to show for the first few days after operation a little impairment of percussion note, weakening of breath sounds and inspiratory râles low down over the right base, even in the absence of any chest discomfort. Such signs are not without other evidence to be interpreted as pneumonic. The part played by the diaphragm in their causation will shortly be discussed at greater length—in the present instance they merely signify that the muscle-fibres of the diaphragm are reflexly on guard over an area of surgical trauma, just as is the upper rectus of the abdominal wall. In the latter muscle the tautness can be directly felt—in the former the protective spasm is hidden and revealed only by the physical signs it produces in the lung.

In this regard, although not strictly the subject of discussion, it is worthy of note in differential diagnosis of surgical conditions *before* operation that signs at the lung base of the same order are commonly to be found at an early stage of any acute inflammatory process in the upper abdomen, especially if associated with spreading peritonitis. Impaired movement of the abdominal wall is accompanied by impaired action and limited excursion of the diaphragm, and a partial collapse of the lung base. Inflammation low down in the abdomen or in the pelvis does not give rise to such physical signs, which therefore assume a diagnostic significance. Differentiation from a primary thoracic lesion does not usually arise in the absence of direct respiratory symptoms.

The degree of collapse of the lung after operation may, however, be of any grade, varying with the general strength of the patient and particularly with the degree of local trauma inflicted on the neighbourhood of the diaphragm. In the mildest cases, with but a slight failure of expansion of both bases, symptoms may be few or pass unobserved. When more marked, symptoms of a mechanical respiratory embarrassment develop, with dyspnoea and cyanosis of corresponding grade, and a moist but unproductive cough. The onset is usually gradual over a matter of hours. When established, expansile movement of the chest is found to be reduced with diminished vocal vibrations, impairment of percussion note or actual dullness, and weakened breath sounds and voice conduction, becoming bronchial in character if absorption of air from the area of lung is complete. Coarse crepitations

are heard on inspiration. Where the signs are markedly unilateral, one base only being involved, displacement of the heart can be made out towards the side affected. The temperature may be normal, but a low-grade fever is prone to develop from infection of retained secretions, and in severe cases without adequate treatment the condition may gradually pass into a true secondary or consecutive pneumonia.

In other instances a more abrupt and striking clinical syndrome is met, now recognised as being due to an extensive collapse or acquired atelectasis of a whole lower lobe or even of the entire lung—the so-called *massive*, “*active*,” or *lobar collapse*. Not until recent years was this condition distinguished from a true lobar pneumonia, which as a post-operative sequel is rare. The same occurrence is met with after penetrating or even non-penetrating wounds of the chest, and in diphtheritic paralysis of the diaphragm.

Symptoms usually appear within two to three days of operation. An abrupt rise of temperature occurs, often up to 102° F. or more, with marked general illness, anxiety, and prostration, pain in the lower part of the chest or the abdomen, increasing dyspnoea and huskiness, and possibly cardiac embarrassment. There is a frequent distressing cough, with the difficult production of thick, viscid mucoid sputum. Examination of the chest soon shows a gross deficiency or absence of air-entry over the affected lobe, more usually the right, following absorption of its contained air, with upward displacement of the diaphragm and shifting of the heart and mediastinum towards the affected side. Failure to notice the latter essential point will lead to error in diagnosis from pneumonia. If the left side is involved, the heart is not only displaced to that side but is also rotated upwards. Over the collapsed lobe there is contraction of the chest with approximation of the ribs and inhibition of thoracic movement, as there is of abdominal breathing on that side. Vocal fremitus is usually diminished or absent, and there is dullness to percussion. The physical signs on auscultation vary in different instances and with the stage of development. The collapsed area is at first silent, sometimes remaining so, with a virtual suppression of breath sounds and voice conduction. Later, there frequently appears well-marked bronchial or tubular breathing, with bronchophony and pectoriloquy. Added sounds are usually absent or consist of a few fine crepitations or bronchitic signs only. At this stage vocal fremitus is increased. Over the opposite lung respiratory efforts are exaggerated, with signs of compensatory emphysema. A raising of the liver dullness may sometimes be distinguished. Though the complete clinical picture commonly develops

in this way in the progress of a few hours, its onset is not necessarily so acute but may sometimes date insidiously from the time of operation.

The chief difficulty in diagnosis is from a lobar pneumonia, in which displacement of the heart does not occur. The appearance of the sputum in pulmonary collapse is a further guide, being mucoid and never rusty or blood-stained. Respiration, moreover, although rapid and shallow, is not grunting in type, and the mind is usually clear. Labial herpes does not develop. There is not the flushed, hot dry skin of a pneumonia patient, but rather a pallid lividity with sweating. An infarct of the lung may cause confusion, but is again accompanied by hæmoptysis and seldom gives rise to such gross signs or extreme degree of illness. In pleural effusion or pneumothorax cardiac displacement is, of course, away from, and not towards, the affected side.

The condition of the patient seldom allows of X-ray examination, but where screening has been carried out the cupola of the diaphragm on the affected side has shown immobility or restricted excursion, with short jerky movements suggesting a tonic contraction and a vertical displacement of its level half-way up the thorax or beyond, and a corresponding shifting of the mediastinum. A skiagram if it can be taken shows a dense, homogeneous triangular shadow of the airless lower lobe with apex at the hilum, and merging with that of the heart, the opacity being more uniform and usually less dense than that cast by a pneumonic lung. A pendulum-like swing of the mediastinum occurs with breathing.

Symptoms of massive collapse persist usually for about three days after their development, when in the majority of cases there is a rapid *improvement with subsidence to normal*. The pain lessens, breathing becomes easier and the temperature falls; cough and sputum usually persist for a few days. Occasionally resolution may be as sudden as was the onset, emphasising the essentially mechanical rather than inflammatory factor in its production. The physical signs in the lung rapidly return to normal as re-inflation occurs.

In other cases stagnation of mucus in the bronchi of the collapsed lobe is accompanied by septic infection of the mucosa, spreading into the adjacent lung tissue as a diffuse pneumonitis. Illness becomes of increasing gravity, the sputum is now abundant and purulent and the condition passes into a typical broncho-pneumonia, which if unrelieved by drainage may prove fatal. Death from an uncomplicated massive collapse is rare. The majority resolve completely, but if damage is severe and pneumonia supervenes recovery is slow and some degree of fibrosis and bronchiectasis may remain.

The *pathology* of the condition is best appreciated by a study of its *ætiology*. There is, however, no general agreement as to its mode of production, the merits chiefly of bronchial obstruction and dysfunction of the diaphragm as responsible factors being variously emphasised. The truth lies in a combination of several predisposing and causative factors acting in conjunction. Inadequate respiratory movement from local trauma to the upper abdomen is undoubtedly the most frequent and important cause. Reflex inhibition of the diaphragm with tonic spasm, or in the most severe cases paralysis, of its muscular interceptions, and rigidity and immobility of the abdominal wall from pain, combine to permit a deflation of the underlying lower lobe. With the exhaustion after operation breathing is reduced to a minimum. With failure of inspiratory expansion and of interchange of alveolar air, that already present in the alveoli is absorbed by the circulating blood, and the immobile lobe undergoes collapse into a shrunken, solid and airless structure. From a post-mortem study of the uncommon cases where death has occurred at a stage of massive collapse without passage into a broncho-pneumonia, Band and Simson Hall (2) have described the appearance of the lung as being heavy and darkly congested, shrunken to somewhat less than normal size, and non-crepitant. *Microscopically*, the alveoli are collapsed and the vessels congested, with extravasation of many red blood cells both in the alveoli and in the stroma, as a physical reaction to the absorption of air and subsequent diminution of intra-alveolar pressure. Sir Charlton Briscoe (3) lays special emphasis in *ætiology* on spasm of the crural portion of the diaphragm. Occasionally an ill-chosen spinal anæsthetic may act similarly by producing paralysis of the lower intercostal muscles, just as lesions of the spinal cord are frequently accompanied by passive congestion and pneumonia. Reflex disturbance of the vagus and sympathetic branches to the lung has been put forward as a contributory cause. From the abdominal aspect, a normal expansion of the lung bases after operation is impeded by flatulent distension of the stomach and intestines from faulty preparation or after-treatment. On the other hand, weakening of the patient from excessive starving or purging prior to operation will also contribute to poor general resistance, shallow breathing and pulmonary collapse. Prolonged deep anæsthesia with slow recovery will act in the same way. A faulty posture while on the operating table, especially if prolonged, and any unconscious leaning on the patient's chest or abdomen are further factors. In the mere opening of the peritoneum the normal slightly negative pressure of the abdomen is lost. It has been shown by Churchill and McNeil (4) that the vital capacity of the chest may

on the day after a laparotomy be reduced thereby to less than half its former figure.

The effects of any factors acting externally from the parietal aspect are accentuated by causes primarily operative within the lung structure. Thus, in the production of collapse inadequate respiratory movement is reinforced by any degree of bronchial obstruction that may be present. Absorption of air from the imprisoned alveoli will occur with correspondingly greater facility and speed. Increase of bronchial secretion, swelling from congestion and œdema of the lining epithelium, and spasm from irritation of the muscular coats of the bronchioles may all be concerned. If from the nature and depth of anæsthesia these are excessive, stagnation and complete blockage occur, aided by further difficulty in removal of the obstruction through a weakening or loss of the cough reflex and depressed ciliary action.

Two further factors tend to accentuate these possibilities and increase the likelihood of occurrence and severity of massive collapse. Any respiratory tract infection prior to operation increases the production of mucus after anæsthesia, while aspiration into a bronchus from the mouth, at the time of operation, of infective mucus, pus or blood may provide the initial nidus for obstruction. In these circumstances progress into actual suppuration is not infrequent.

Bronchoscopy in these cases has shown the main bronchus or bronchi of the affected lobe to be blocked by a tough plug of inspissated mucus and fibrin, the removal of which, although it is not necessarily the primary cause of the obstruction, promotes a return to normal expansion. It is not likely that a mucous plug is the sole cause of a lobar collapse, or that it has a ball-valve action. Its formation and inspissation is always a slow process, whereas frequently the symptoms of collapse are characterised by an onset in dramatic fashion.

The course of a case of pulmonary collapse, whether of partial or massive type, depends very largely on the nature and degree of bacterial growth in the affected bronchioles. If they contain only saprophytic mouth organisms of feeble or no virulence, changes in the lung do not supervene, pyrexia is slight, and, other things being equal, the mucus is usually coughed up after a few days, with speedy improvement. If, on the other hand, more highly pathogenic organisms remain sealed up in the air-passages without exit, they grow under ideal conditions, pus is poured out and pneumonia, abscess, or overlying pleurisy may develop, with prolonged severe illness, and possible permanent damage. In the majority of uncomplicated cases the prognosis is good.

Treatment of Pulmonary Collapse. Considerations of treatment will, in principle, follow naturally from a study of the causes already enumerated. Preventive measures, which are of even greater importance, will be discussed fully in considering at a later stage the means of avoidance of post-operative chest complications as a whole. To summarise, apart from pre-operative care the essence of prevention of collapse consists in the maintenance and assistance at each stage of a full respiratory excursion.

Minor degrees of collapse are extremely common and, their symptoms being slight, are masked by the primary abdominal condition. Consequently, no detailed examination of the chest being made, the condition unless searched for is overlooked, the patient recovering without any special treatment.

When the clinical syndrome of pulmonary collapse is established and recognised, the therapeutic measure of the greatest importance is the promotion of the fullest possible ventilation of the lower lobes by artificially increasing the depth of breathing. The greatest advance in this regard has been the recognition of the value of carbon dioxide inhalation. Prophylaxis should, of course, start right from the time of operation, but where this has not been done and severe symptoms have already supervened the patient should be made to inhale a carbon dioxide mixture for periods of five to ten minutes at a time, at intervals of an hour or less according to his condition and tolerance. The optimum strength of the mixture and the length of inhalation will vary with the individual needs of each patient, the object being to produce and maintain the maximum degree of respiratory ventilation. Oxygen with CO_2 in from 5 to 10 per cent proportion may be inhaled from a bag and mouthpiece, or by using a Boyle's anæsthetic apparatus if available, in which instance the administration may be made continuous and the percentage of CO_2 varied with the immediate need. Haldane's apparatus is also convenient, giving the desired percentage mixture of CO_2 and air. Some employ as a routine a strength of 30 per cent CO_2 .

If the need is urgent and respiratory embarrassment is marked, pure carbon dioxide gas may be inhaled from a cylinder connected to a large glass funnel held two or three inches from the face. Breathing becomes deep within a few seconds and the administration can be kept up without discomfort or harmful effect for five minutes or longer. Relief is usually rapid, and as the condition improves and the lung re-expands the frequency may be reduced, i.e. to applications at 4- or 6-hourly intervals. With the greater depth of breathing the cough loses its constant fruitless nature and with the bringing up of sputum is

abated and so allows of refreshing sleep. Recovery is usually complete in early cases within 48 hours. Contrary to what might be thought, in this artificial hyperventilation with CO_2 the breathing is not painful compared with the distress endured in taking voluntary deep breaths after operation.

Apart from CO_2 administration general stimulants may be helpful. Their use, however, is now subsidiary to CO_2 and dates from the time when they were the sole means of treatment available. Coramine is given intravenously especially where, with undue depth of anæsthesia, suppression of the cough reflex has taken place, as after some avertin cases. Adrenalin, 5 minims of the 1 in 1000 solution hypodermically, diminishes any associated bronchial spasm and is said also to lessen spasm of the diaphragm. Pituitrin $\frac{1}{2}$ cc. has been given with a similar purpose. Atropine sulphate, $\frac{1}{100}$ gr. subcutaneously, stimulates the respiratory centre and diminishes secretion of mucus. Stimulating expectorants such as ammonium carbonate, potassium iodide, stramonium and alkalis thin out the bronchial secretion and aid its removal when expansion is restored. Strychnine and digitalin given hypodermically may also be of value, while moist inhalations may be given, together with a light poultice or blister to the affected side to relieve pain and to provide counter-irritation to the phrenic nerve. Such general measures are especially helpful where infection has supervened, the sputum has become purulent and development of a broncho-pneumonia is feared.

When in spite of these medical measures no relief is afforded within 12 to 24 hours and the condition is severe enough to justify the procedure, a bronchoscope may be passed under local anæsthesia and direct aspiration of inspissated mucus employed, frequently with good or even dramatic results. Search is made for any redness and swelling of a lower lobe branch, perhaps with complete occlusion. Because of the bronchial obstruction, little or no pus may be seen. A fine flexible-ended suction tube is passed down the suspected bronchus and if successful will release pent-up purulent secretion either at once or after aspiration. Much purulent sputum is brought up and rapid improvement occurs even after a single bronchoscopic treatment (Negus [5]). By some exponents such a measure is advocated as soon as the diagnosis is made, but obviously the simpler treatment should first be given an adequate trial. Bronchoscopic aspiration is applicable especially where collapse of the whole lung has occurred and efforts to dislodge the viscid sputum are completely ineffective, as also in those cases of collapse slow in clearing up, where the development of bronchiectasis is suspected.

III. PULMONARY INFARCTION AND EMBOLISM

The lung belongs to the group of organs whose blood supply is by end-arteries with but scanty collateral channels. Obstruction, therefore, of a branch of the pulmonary artery leads always to hæmorrhage into the alveoli and surrounding interstitial tissue of the zone supplied, producing an infarct, usually wedge-shaped and situated at the periphery of the lung.

Infarction may result from the local thrombosis of such a vessel. In post-operative cases it occurs far more frequently from the lodgement in its lumen of a detached portion of blood clot or other tissue carried by the venous circulation from a distant area of the body. In the strict sense all such events are embolic, whatever be the size of the liberated clot; if this be but small, the effects are in the main local in the lung; if large, there results an immediate circulatory catastrophe with perhaps total arrest of the blood-flow and death, through a sudden blockage of the pulmonary artery itself or one of its main divisions. Although the distinction is thus one only of degree, by some the term "pulmonary embolism" is reserved for this latter fulminating group, while the effect of a smaller embolus is designated "infarction."

Not always does the embolus consist of blood clot, although this is the only common variety. Occasionally fat globules or bubbles of air are liberated at operation into the blood stream, with resulting special symptoms which are described later.

As with those pulmonary complications already described, in the large majority of cases pulmonary infarction or embolism follows either an abdominal, or even more often, a pelvic operation. Operations on the uterus or rectum seem especially predisposed. The patient is usually an adult over 30 years of age. The complication is by no means confined to cases where sepsis is present, but is nevertheless commoner where there is cellulitis or peritonitis and drainage has been needed. A further factor is the presence of a mild degree of septic infection in teeth, gums, tonsils, or other distant focus, tending to increase the chances of thrombophlebitis. There is usually a mild degree of fever after the operation preceding the occurrence of the embolism.

The common source of *embolism* is from a thrombus in the veins of the lower limb, especially in the left iliac or femoral vein, where outward evidence may be found. Small emboli may originate in a peripheral leg vein of lesser size or in a thrombosed vein in the mesentery or abdominal wall. In addition to the factor of mild sepsis, causing damage to

the endothelium, thrombosis in these vessels is rendered more likely by a general slowing of the venous blood-flow. Normally the propulsion effect of voluntary muscular contraction and the suction effect of the negative intra-thoracic pressure during inspiration combine to maintain a steady return of venous blood to the heart. The enforced immobility after operation, together with inhibition of abdominal breathing lead to a sluggishness of the venous circulation in the limbs, which in the obese is increased by the direct weight of a sagging pendulous abdomen on the upper thighs, while the effect of operative injury to the tissues is to liberate into the blood stream the thrombus-producing factor or thrombokinas. A dehydration of the body and reduction of blood volume by purging before operation will act in a similar way. Less commonly a thrombus may become detached from the right side of the heart when dilatation or mitral disease is present, and lead to a pulmonary infarct.

A *small infarct* is characterised clinically by the abrupt onset of sharp stabbing pain in the chest over the site of the lesion, with dyspnœa and distress of proportionate degree. There is some cough and cyanosis, followed within a few minutes or hours by the bringing up of blood, either as a frank hæmoptysis or as deeply blood-stained crimson mucus which persists for some days and slowly clears up. Pulse and respiration are quickened, and on examination of the chest confirmatory signs may be found in an area of impaired resonance and weak or bronchial breath sounds. In some cases pleural friction is heard over the infarcted area. Suppuration is rare owing to the low grade of infectivity of the embolus.

With a *larger infarction* severe shock is present, with orthopnœa, laboured breathing, sweating and lividity. When a large embolus obstructs a main pulmonary artery, there is a sudden intense anxiety and distress, gasping for breath, severe cutting pain in the chest, a dusky pallor with distended veins in the neck and feeble flickering pulse. There may be at the onset an urgent call to stool. Rapid loss of consciousness and death may ensue within a few minutes or even seconds. About half such severe attacks prove fatal. At post-mortem a large clot, usually from an iliac vein, is found lodged across the bifurcation of the pulmonary artery.

A *major embolism* of the pulmonary artery is, therefore, of all post-operative chest complications the most to be dreaded. It may come completely unheralded to a case otherwise progressing uneventfully. The incidence in major operations of all classes is in the region of 0.1 per cent, while the interval after operation

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during which it most often occurs is between the fifth and twelfth days.

Fat-embolism is much rarer than the ordinary variety and frequently proves fatal. It is most apt to follow fractures of the shafts of long bones, especially of the femur, but is occasionally met with after bone operations, widespread blunt dissection of fatty subcutaneous tissues or lacerations of the liver. Symptoms come on within a few hours. The fat globules are at first held up in the capillaries of the lung, with cyanosis, dyspnoea, and signs of coarse pulmonary oedema, but they gradually filter through and come to obstruct the capillaries of distant organs, where minute hæmorrhages occur. It is in the vessels of the brain and coronary circulation that their effects are most serious or fatal, the patient dying from coma or cardiac failure.

Air-embolism produces similar but more rapid effects, the risk being greatest in thoracic operations where air may be sucked into the open lumen of a vein straight into the left auricle and so on to the general circulation. Cerebral embolism, with convulsions, hemiplegia or coma may follow.

Prevention of post-operative pulmonary embolism. The chief mode of prevention of pulmonary embolism is by aiding a normal venous circulation and overcoming those factors which lead to stagnation and thrombosis. Excessive immobility of the patient after operation is undesirable. Wherever possible, and provided, of course, that thrombosis has not already occurred, gentle movement of the limbs and encouragement of the patient to turn about freely in bed are therefore indicated, aided by daily upward massage of the limbs where active movement cannot be allowed. Breathing exercises are also of benefit in prevention. Tight bandages should be avoided.

Similarly, foci of septic infection should as far as possible be cleared up before operation.

Any unnecessary loss of fluid before operation by violent purging or starvation is to be deprecated. Similarly, the volume of circulating blood is to be fully maintained after operation by giving fluids freely. Where the diet is principally milk this is especially necessary. Sodium citrate in doses of 30 grains t.d.s. is said to reduce the incidence of thrombosis by diminishing the coagulability of the blood.

From the standpoint of surgical technique any tearing of tissues should be reduced to a minimum and the maximum gentleness employed.

When thrombosis of a peripheral vein has once occurred, the limb must be immobilised and all sudden or violent body movements avoided until the clot is firmly organised.

Treatment. In pulmonary infarction the measures of treatment indicated are those to combat shock and collapse. If the infarct is large, morphia $\frac{1}{6}$ gr. should be given with atropine $\frac{1}{100}$ gr., and oxygen administered. If the right side of the heart becomes distended, removal of half a pint of blood by venesection is of assistance.

For a gross pulmonary embolism there was until recently considered to be no effective treatment except by these measures. The introduction by Trendelenburg of the operation of pulmonary embolectomy, dealt with in detail on page 2165, has on a number of occasions allowed of the successful removal of the obstructing clot with recovery of the patient. Allowing that the indications must be clearly defined, it is an operation which should be attempted in every suitable case, for when successful it is positively life-saving.

IV. POST-OPERATIVE PNEUMONIA

(a) *Lobar pneumonia*

True pneumococcal lobar pneumonia is one of the least common sequelæ to operations. As already stated, it was formerly misdiagnosed in many cases of post-operative collapse. When seen, it is due to the lowering by operation of the patient's general resistance to a pneumococcus harboured in the throat. An antecedent catarrh has often been present. The onset of the pneumonia is usually about a week after operation, and the course, symptoms and signs in no way differ from the normal attack except in their usual lack of severity and tendency to early termination by crisis. The prognosis is generally good. Specific treatment is seldom indicated or applicable.

(b) *Broncho-pneumonia*

Broncho-pneumonia following operation may fall into one of two groups. The most severe cases are those which develop abruptly, usually within a few hours of operation, in an enfeebled subject from the rapid tracking down of infection to the smallest air-passages, either from a lack of general resistance or from a gross direct aspiration of septic matter into both lungs. Generally speaking, the earlier the

development of a broncho-pneumonia the more intense is its severity and the greater the risk of a fatal ending.

The other type is that which develops usually at a later stage, as a secondary pneumonic change in a zone of lung already collapsed.

In the fulminating variety first alluded to, such collapse as occurs is patchy and secondary to the occlusion of small bronchioles by inflammatory changes set up by the infecting organisms, usually pyogenic cocci. The condition is ushered in by a rapid rise of temperature, marked prostration, and rapid shallow breathing. There is a constant irritating cough, at first dry and ineffective, while the colour becomes cyanosed with working of the *alæ nasi*. The pulse is frequent and feeble, and the tongue and lips soon become dry with thirst. Apart from the quickened breathing and cough there may be little pain or subjective complaint, the mental state being clouded. There may be delirium, and sometimes restlessness, but with the progress of the infection the patient becomes drowsy and torpid, sinking down in the bed, while breathing ceases to be an effort. Such signs are of bad omen and foretell a failure of the respiratory centre.

Physical signs in the chest are at first scanty, with rhonchi over the upper chest and weak or harsh breath sounds over both bases. Later, the note is impaired, with signs of patchy consolidation, perhaps bronchial breathing, although not necessarily present, and scattered râles over both lower lobes, becoming abundant, coarse and bubbling in character. At this stage a highly purulent frothy sputum is produced, but if weakness is marked it may not be expectorated, remaining in the air-tubes where its presence is deduced from the rattling type of respiration. Inspiratory recession of the intercostal spaces may be evident and signs of circulatory failure develop.

In those cases which recover, the course is prolonged over several weeks with remittent fever and ultimate subsidence by lysis, while resolution and convalescence are slow.

Where broncho-pneumonia supervenes after an initial stage of collapse, the signs and symptoms of onset are as already described, though generally of severe degree. The patient is frequently debilitated, elderly, or the subject of previous cardio-renal or respiratory disease. The onset is delayed for some days after operation and less fulminating, and the distribution is usually unilateral.

Transition to a state of pneumonia is shown by increase in the severity of illness, usually a higher grade of fever, greater respiratory distress, with abundance of coarse basal râles, and a change in the

character of the sputum, which is no longer mucoid but becomes mucopurulent or purulent, perhaps blood-stained, and usually abundant in amount. Bronchial obstruction is seldom complete, but where so the volume of sputum may be small; such complete blockage is apt to be followed by actual suppuration and breaking down of lung tissue, with formation of an abscess or area of gangrene.

In the collapsed area, those micro-organisms present only as saprophytes may undergo an enhancement of virulence, and together with any pathogenic organisms present (chief among these being various streptococci and pneumococci) invade the walls of the bronchioles and alveoli. Edema, congestion, hæmorrhage and desquamation of epithelium occur with outpouring of leucocytes, consolidation and subsequent softening of tissues. If the general resistance is adequate, after a long course the infection may be overcome, especially if the causative factors are relieved. In any case, dilatation occurs of the weakened and obstructed bronchial walls, with overgrowth of the interstitial tissue, so that some degree of bronchiectasis and pulmonary fibrosis is a very common sequel to this type of pneumonia.

The clinical aspects of pulmonary suppuration are considered in a separate section, but for the sake of completeness the pathology of one variety may conveniently be described, i.e. suppuration occurring in a collapsed lobe. If the infective process referred to above be of unusual virulence or the resistance of the patient be below normal, the initial state of simple broncho-pneumonia may progress into a stage of diffuse suppuration. The areas of consolidation become confluent and then undergo an irregular suppurative softening. The zone of lung affected becomes riddled with multiple small abscesses, originating chiefly in obstructed bronchioles and hence termed bronchiectatic abscesses, while the lung tissue in between shows a mixture of pneumonic consolidation and boggy œdema. To such a condition the term "diffuse septic pneumonitis" is often applied, being but one step removed from lung abscess or gangrene. Spread of suppuration to the pleura is a not unusual event, with resultant empyema, or actual rupture may occur with pyo-pneumothorax. The zone of lung affected varies, the lower lobe being the most frequent. In pulmonary suppuration as a whole, apart from the factor of infection, that of bronchial obstruction (e.g. by aspiration as in throat operations) is nearly always present and the site of localisation of disease will, therefore, vary accordingly. Any part of the lung may thus be involved, or rarely with a fulminating infection the condition may be widespread throughout both lungs.

Treatment of Post-operative Pneumonia. The prevention and treatment of this condition are to a considerable extent included in the consideration of post-operative collapse. It is, however, of even greater importance to attack and, where possible, relieve any factor of bronchial obstruction. Where the signs point to retention of septic secretion or the possibility of a foreign body, bronchoscopy under a local anæsthetic should be carried out and an attempt made to relieve the obstruction, with repeated aspirations as indicated.

Apart from this special treatment reliance must be placed largely upon general measures, the aim being to support resistance to infection and to promote drainage. Good nursing throughout the 24 hours is essential, with abundance of fresh air, a warm room, and avoidance of any unnecessary disturbance or exertion of the patient. Where the abdominal condition will allow, it is of the utmost importance to persuade the patient to take the largest possible quantity of fluid short of causing embarrassment of the circulation, so that the maximum dilution and excretion of toxins by the kidney and skin may be obtained. The aim should be from five to six pints in the 24 hours, the nature of the fluid being less important than its volume. Almost any simple fluid may be allowed—milk, citrated and diluted with half-volume of water or soda-water, the various preparations with a milk basis such as Benger's Food, lemonade, imperial drink, meat essences, weak tea or coffee. It is wise not to exceed two pints of milk in one form or other during the day on account of the tendency to meteorism. Beaten-up eggs may be given, and sugar added to each feed in the form of glucose or lactose, giving if possible a pound in the day. The patient should if awake be fed every hour. Alcohol is of value if there is restlessness, as a soporific and sedative, and may be given as brandy, whisky or champagne.

Where it is not permissible to give or to push fluids by mouth, they must, unless contra-indicated also by that route, be given by the bowel, as normal saline, to which 5 per cent glucose may be added. A volume of half a pint may be repeated 4-hourly and is usually retained if given sufficiently slowly. Alternatively, a continuous drip infusion may be made. Normal saline may if required be given subcutaneously into the axillæ or pectoral regions. It is not advisable to give large injections directly into a vein if pneumonia is present because of the danger of distending the heart, but concentrated solutions of glucose, e.g. 10-20 per cent, may be given in 50 cc. bulk of saline, or saline alone may be allowed by gravity to flow very slowly into a vein as a continuous drip, where other routes of giving fluid are not available.

Where large quantities of sugar are given, the subcutaneous injection of insulin 10 units b.d. is of help in aiding its rapid utilisation.

Careful cleansing of the mouth and tongue after each feed is important, and a free flow of saliva guarding against the occurrence of parotitis is helped by allowing chewing gum or acid drops. Abdominal distension seriously impedes the heart and lungs, and attempts must be made to prevent or relieve it by the usual methods.

The patient should be nursed well propped up with pillows or a bed-rest. In this posture breathing is easier and deeper and efforts of coughing more productive, while any slight increase in the work put upon the heart is more than counterbalanced. If the colour is poor oxygen should be given continuously by nasal catheter, substituted at intervals by an oxygen with 5 per cent or 10 per cent CO₂ mixture to obtain a greater depth of respiration where it is rapid and shallow. The catheter is usually well borne if lubricated with a little 2 per cent cocaine or novocaine ointment. Some patients will with advantage tolerate inhalation through a mask or Haldane apparatus.

Expectoration is to be encouraged by stimulating drugs such as ammonium carbonate or chloride, potassium iodide, and alkalis such as potassium citrate or sodium bicarbonate which shorten the raw unproductive stage of inflammation and help to make the sputum less tenacious and easier to bring up. If any drug by mouth is, however, found to interfere with appetite or to upset the stomach it should be discontinued and equivalent treatment given by the hypodermic route. Caution is to be observed with regard to sedative linctus and morphia in particular. Whereas in the early stages of lobar pneumonia, with its severe pleural pain and restlessness and relatively "dry" chest, its exhibition is good treatment, in the presence of generalised bronchitis and abundant secretion any further depression of the respiratory centre may be disastrous. In broncho-pneumonia, therefore, cough in general must be promoted and not quietened, and morphia withheld. The indication for pain is usually absent or adequate relief is obtained from antiphlogistine or a light poultice, with hot bottles or an electric blanket if available. Heroin and codein are also best avoided. The early non-productive cough may be eased by hot drinks, inhalations, or a simple linctus of squills, paregoric or tolu.

Sleeplessness is best relieved by paraldehyde, chloralamide and bromide, or a preparation of the barbitone group such as medinal or allonal. Tepid or warm sponging is of value in this regard in allaying restlessness and promoting sleep.

The condition of the heart and circulation calls for constant

observation. Physical examination of the heart is often obscured by the gross pulmonary signs, but the position of the apex beat, the frequency, volume and tension of the pulse, with estimation of the systolic blood pressure, are reliable guides. Engorgement of the venous circulation, shown by marked cyanosis and tense veins in the neck, is an indication for venesection. Digitalis is of value in moderate doses of say 40-60 minims a day from the onset of symptoms, or given as Nativelle's digitalin $\frac{1}{4}$ gr. 8-hourly if there be any gastric upset. With signs of cedema of the bases and abundant sputum, atropine sulphate $\frac{1}{60}$ gr. should be given hypodermically 4-6-hourly in an attempt to prevent waterlogging of the lungs, and with a falling blood-pressure may be well combined with strychnine $\frac{1}{4}$ gr. injected at the same time. Other more rapidly acting cardiac stimulants are adrenalin, 5-10 minims of the 1 in 1000 solution, and pituitrin $\frac{1}{2}$ -1 cc. subcutaneously, while camphor, coramine and caffeine sodium salicylate are of value intramuscularly. In acute heart failure strophanthin $\frac{1}{60}$ gr. is useful but must not be repeated in less than 12 hours. The value of intravenous glucose as a cardiac stimulant may be emphasised.

Drugs, however (if carbon dioxide be excepted), form a subsidiary line of treatment compared with nursing, general care and avoidance of any mechanical embarrassment to breathing. What is given should therefore be chosen with care and with definite indications, and the danger of panic-treatment by flooding the patient with drugs in the late stages resisted.

Opportunity for specific treatment by sera does not often arise. Pneumococci present are usually of nondescript type; if a predominance of streptococci is found from examination of the sputum, the giving of concentrated anti-streptococcal serum, 20 cc. intramuscularly, is sometimes of benefit, using either anti-scarlatinal globulin or mixed polyvalent serum as indicated from the type of organism isolated.

Where recovery occurs, convalescence must be gradual and the fullest use made of breathing exercises and massage to aid restoration of function of the affected lung tissue.

V. PULMONARY SUPPURATION

(a) *Diffuse suppurative pneumonitis*

The development of a widespread septic infiltration of the lung from a state of broncho-pneumonia has already been briefly described, and emphasis laid in its ætiology upon the factor of bronchial

obstruction. A damming-up of secretions through inflammatory swelling of the walls, shedding of epithelium and blocking of the lumen of the bronchioles leads to their mechanical distension. The free growth of organisms under favourable conditions and outpouring of leucocytes is followed by a patchy softening and destruction of the alveoli and lung parenchyma. The distribution is often confined to a single lobe, which becomes replaced by multiple small abscess cavities interspersed among disintegrating lung and granulation tissue. The structure of the lung thus becomes completely disorganised. Illness is extreme and the prognosis serious, for unless free drainage can be established by relieving the bronchial obstruction a fatal result usually follows, while in any case permanent lung damage is inevitable.

Bronchoscopic aspiration is strongly indicated if the nature of the condition is recognised; in other ways the case is treated as already considered under "Broncho-pneumonia", from which indeed it is frequently not possible to distinguish it. Since the suppurative process is diffuse, no external method of surgical drainage is available.

(b) *Localised pulmonary abscess*

Where the suppurative process is more circumscribed and limited in its intensity a definite, single localised abscess is formed in the lung parenchyma by the further breaking down of alveolar barriers between the loculi and a walling-off of the infection at the periphery of the inflamed area. Such a lung abscess is a considerably more common sequel to operation than is generally recognised, as more precise methods of investigation have shown. Moreover, of all cases of lung abscess, about three-fourths are post-operative, the remainder being associated chiefly with pneumonia or malignant growth.

The clinical aspect may be first considered. The operative procedures most often followed by lung abscess are those on the region of the upper respiratory tract, including the mouth, nose, naso-pharynx and throat. In any record of cases, two operations stand out as pre-eminent causes, namely, removal of tonsils and dental extractions, usually under general but sometimes even under local anaesthesia. It is estimated that lung abscess follows tonsillectomy in between 1 in 2000 and 1 in 3000 cases. Nearly always the abscess results from the inhalation into a bronchus of infective material or foreign body, e.g. portion or whole of a tooth, blood clot, pus from the tonsil, vomit or swab. The more marked the degree of sepsis present the greater is the risk of such a sequel—in fact, the operative factor may not be needed at

all, abscess of the lung being met with not infrequently in severe septic conditions of the nose and naso-pharynx apart from operation.

Detailed consideration of the ætiological factors and means of prevention of lung abscess and gangrene is given in the general review of prophylactic measures in a later section.

An aspiration abscess is more often found on the right side than the left in the proportion of about three to one. The upper zone of the lower lobe is the site most commonly involved, but the upper lobe is by no means immune owing to the effect of aspiration in a recumbent patient lying on his side.

Embolic abscesses do occur, but much more seldom. They are multiple, scattered throughout the lungs chiefly at the periphery and therefore unsuited to any sort of surgical treatment even if the condition is recognised. They usually originate from a septic thrombophlebitis in a distant part of the body, as, for example, in acute osteomyelitis, the local complications of otitis media, or septic lesions of the skin. The ill-judged surgical treatment of a carbuncle may be the starting-point of pulmonary dissemination. Such multiple abscesses are frequently staphylococcal, and rupture into the pleura with empyema is common. The prognosis is, of course, very grave.

The development of an acute inhalation abscess is usually shown by the onset of severe respiratory symptoms at an interval after operation of from 7 to 10 days or longer. The history is of the greatest importance in diagnosis, which indeed can often be made with a considerable degree of certainty upon this basis alone. Its value exceeds beyond question that of physical signs, which may at this stage be absent, equivocal, or even misleading. Physical signs and X-ray examination are of greater help in confirming and localising the lesion.

Onset is in most cases acute, with high fever becoming usually intermittent with severe rigors and sweats. Prostration is marked, with frequent pulse, dyspnoea, and some cyanosis. A paroxysmal cough develops with increasing fever, culminating in the copious expectoration of pus, the sudden discharge of which into a bronchus may coincide with a temporary fall or abatement of the pyrexia. The sputum at this stage consists almost entirely of pus and is of foetid odour, with, perhaps, recognisable elastic fibres or fragments of lung tissue if any gangrenous destruction be also present. It is worthy of note and sometimes of diagnostic significance that offensive smell to the breath or bad taste in the mouth may be noticed, perhaps by the patient, some days before actual rupture of the abscess occurs. The

amount of sputum produced and its character vary with the stage of development of the abscess and its freedom of drainage. There is no characteristic sputum unless and until rupture into a bronchus takes place, when the scanty muco-purulent sputum previously present is succeeded by the sudden expectoration of a large quantity of stinking pus. If the abscess has reached a large size before discharge the volume of pus coughed up may be enormous, a pint or more, with actual danger of suffocation of the patient or development of a septic pneumonia from aspiration into the opposite lung. Such an event can seldom signify other than a lung abscess, since the coughing up of an empyema usually occurs at a much later stage of illness. Where signs of cavitation follow at once the diagnosis is even more certain.

Hæmoptysis of some degree is present in most cases, varying from mere streaking of the sputum to a free hæmorrhage. Its presence after an operation before characteristic rupture is again suspicious of a developing lung abscess.

After its initial discharge the character of the sputum varies with the progress of the abscess cavity. Usually several ounces are produced during the day, in favourable cases gradually diminishing as the cavity grows smaller on healing, and at the same time becoming gradually less offensive and purulent. The amount, however, often fluctuates from day to day; a temporary diminution of sputum, accompanied by exacerbation of illness and increase of fever, signifies inadequate and intermittent discharge into a partially blocked bronchus after the initial perforation, sometimes described as "spill-over" drainage. Pus and debris collect in the closed abscess cavity with increasing distension, until the œdematous opening yields under pressure and allows of a partial evacuation only, with subsequent recollection. In a good many of such instances the site of drainage is on the upper aspect of the abscess and is therefore inefficient.

In chronic cases the sputum assumes features resembling those of bronchiectasis, separating on standing into three layers, frothy mucus above, a turbid serous intermediate zone and a heavy deposit of pus. The odour is offensive, owing largely to the anærobic and putrefactive organisms present. Again, as in bronchiectasis, there is definite relation to posture, alteration of which, especially downward inclination of the chest, by emptying the cavity, leads to a free production of sputum.

Physical signs do not indicate the diagnosis in any certain fashion. When, as is often the case, the abscess is situated deep in the lung adjoining the hilum no abnormal signs may be elicited or, at the most, some

impairment of movement, of percussion note and of air-entry. If the abscess is more peripheral, or as it grows towards the surface, signs appear indistinguishable from those of ordinary pneumonic consolidation, though usually less widespread, with crepitations over the adjacent area from oedema and congestion of the lung tissue. There is thus no pathognomonic sign of abscess, and with the progress of the case the signs may resemble those of consolidation, localised pleural effusion or cavity formation of any variety. In most cases classical signs of cavitation are absent from start to finish, even after rupture, but where they then appear for the first time the diagnosis may be made with great confidence. If by the time of observation infection of the pleura has already occurred, the evidence of abscess may be masked by signs of fluid in the pleura, either clear, turbid or a frank empyema. The radiological appearances are then also obscured by complete obliteration of the lung shadow on the affected side. In a chronic case the tongue becomes thickly furred, and the skin coarse and sweating, with early clubbing of the fingers. With inadequate drainage wasting and anæmia soon become evident.

Diagnosis is aided, sometimes alone revealed, by *X-ray examination*, which is *essential* for localisation before any surgical treatment is considered. Films in different planes are needed, antero-posterior, oblique, and strict lateral exposures, which are usually of more value than stereoscopic views. Repeated examinations are required to determine progress. The early stage of a diffuse pneumonitis is shown by a dense homogeneous shadow in the affected part of the lung field, with ill-defined margin and irregular contour (fig. 1054). As breaking down of lung-tissue takes place, the shadow becomes more rounded and defined, the zone of surrounding consolidated lung being reduced in width (fig. 1055), and following communication with a bronchus is generally seen to contain a central cavity (fig. 1056). In some cases a horizontal fluid level is seen in the erect position (see fig. 1059). The formation of gas by anærobic organisms will sometimes also cause such a fluid level to appear in an abscess which is still closed. Not always is a fluid level seen, however, for some lung abscess cases die after many weeks unruptured, having shown an inconclusive appearance throughout. Moreover, the disappearance of a cavity formerly seen may only signify that it has filled up and is no longer able to drain. Differential diagnosis has to be made from interlobar empyema, pneumonia and bronchiectasis, and is aided by screening in different planes and, after the acute stage if the patient's state permits, by lipiodol injection. In the majority of cases it is found that lipiodol fails to enter the cavity or



Fig. 1054.—Pyogenic Abscess of Right Upper Lobe following Septic Tonsillitis; Early Stage of Diffuse Pneumonitis.



Fig. 1055.—Same Patient as in Fig. 1054, Lesion becoming more localised, with commencing breaking down of lung tissue.

even the zone of the abscess, being prevented by oedema and obstruction of the bronchial mucosa (figs. 1057 and 1058). Entry and definition of the cavity is more probable where the lipiodol is injected by the bronchoscopic route. The heavy oil is then seen to be at the bottom of the cavity, displacing the purulent contents by its weight, and a double fluid level is evident in an erect film (figs. 1059, 1060 and 1061). The method is also of value in cleaning the cavity in treatment.

The more chronic an abscess cavity the tougher and more fibrous do its walls become, casting a correspondingly denser X-ray shadow. Owing to the surrounding fibrosis of lung tissue, however, the actual cavity may become more difficult to identify. An abscess which



Fig 1062—SAME PATIENT AS IN FIGS. 1064 AND 1065, LESION FURTHER DEFINED, WITH WELL MARKED CENTRAL CAVITATION BUT NO EVIDENT FLUID LEVEL.

ruptures early into a bronchus with free spontaneous drainage will on healing leave but slight residual radiographic evidence of its former existence, perhaps no more than a puckered scar within only a few weeks of closure.

Bronchoscopy is of most value in excluding the presence of a foreign body such as a tooth. If there is the least doubt as to this possibility direct inspection should never be omitted. It may also be helpful in aiding localisation of the abscess. Search is made for a localised swelling of the bronchial mucosa producing an inflammatory stenosis of the lumen. Such a narrowing is one of the most significant causes of retention of pus leading to the formation and persistence of a lung abscess, the ring of inflammatory tissue becoming organised into a firm fibrous collar which undergoes a steady contraction. The value of bronchoscopic



Fig. 1057.—CHRONIC LUNG ABSCESS OF RIGHT MID-ZONE, WITH BRONCHIECTASIS OF LOWER LOBE, BEFORE LIPIODOL INJECTION.



Fig. 1058.—SAME PATIENT AS IN FIG. 1057, AFTER INJECTION OF LIPIODOL BY CRICO-THYROID ROUTE. THE LIPIODOL HAS NOT ENTERED THE CENTRAL ZONE OF THE ABSCESS.



Fig. 1039.—POST INFLUENZA ABSCESS OF RIGHT UPPER LOBE, IN ERECT POSITION, SHOWING CENTRAL CAVITY WITH HORIZONTAL FLUID LEVEL.



Fig. 1040.—SAME CASE AS IN FIG. 1039, TAKEN IN ERECT POSITION AFTER INJECTION OF LIPIODOL BY THE BRONCHOSCOPIC ROUTE, SHOWING PARTIAL FILLING OF THE CAVITY, WITH A DOUBLE FLUID LEVEL.



Fig. 1061.—SAME CASE AS IN FIGS. 1059 AND 1060, FILM TAKEN RECUMBENT.

(Figs. 1057 to 1061 are reproduced by the courtesy of Dr. Scott Pinchin.)

dilatation of such a stricture is obvious. In many cases it will be determined from a diagnostic bronchoscopy whether aspiration by this means is feasible, or whether direct surgical drainage is a preferable mode of treatment.

A leucocyte count may be of help in diagnosis, the acute stages of lung abscess being marked by a moderate or high polymorphonuclear leucocytosis. Examination of the sputum also furnishes information of value, giving direct evidence by elastic fibres of destruction of lung tissue. Bacteriology is better revealed by examination of direct films than by culture, owing to the frequent presence of spirochaetes, Vincent's organisms and anaerobic bacilli, and their difficulty of isolation.

The temptation to explore a suspected abscess with a needle without special precautions is to be strongly resisted, for the danger of conveying infection thereby to the general pleural cavity is considerable, with an ensuing septic or even fatal pyo-pneumothorax.

Course and complications. Where the patient coughs up the contents of his abscess and satisfactory drainage into a bronchus is established, a rapid improvement in the general condition follows, with subsidence of fever, sometimes an abrupt fall to normal, and steady diminution of

sputum. Spontaneous rupture may occur within 2-3 weeks of onset, and within a further month the sputum should be reduced to half an ounce or less in amount and have become largely mucoid in character. Where rupture fails to occur, the resistance of the patient may be overwhelmed, and death may follow from toxæmia and the severity of the infection. Gangrene of the lung may develop in such circumstances. Where drainage is inadequate, a prolonged course with fluctuations in the degree of fever and of general illness and in the quantity of sputum may occur. Many such fail to heal, and develop secondary progressive bronchiectasis in the distal area of lung with daily production of many ounces of foetid sputum and possible amyloid disease. The bronchiectasis may then dominate the clinical picture and confuse the diagnosis. Rupture may occur not into a bronchus but into the pleural cavity with resulting empyema or pyo-pneumothorax. Metastatic complications are not uncommon in such chronic cases, e.g. septic arthritis and especially cerebral abscess, which is usually fatal. In chronic lung abscess where drainage and healing are not established the prognosis is bad, with a slowly progressive, downhill course, and usually a fatal termination within two to three years.

Treatment. In the acute stage of lung abscess the treatment is invariably medical, at least until the inflammatory process becomes localised by a protective barrier of reaction in the lung tissue. No good can be expected from attempting to drain an area of diffuse inflammatory consolidation by operation. Moreover, about 20 per cent of abscesses undergo spontaneous rupture into a bronchus with complete healing under medical treatment, which is therefore always to be given a fair trial. The chance of recovery in this way is greater with abscess of the upper lobe.

The acute case is, therefore, to be treated very much on the lines of a case of acute pneumonia, with regard to feeding, nursing, and general medical care. Stimulants should be given freely.

When the favourable course of rupture into a bronchus occurs, great care must be taken to avoid risk of aspiration into the sound lung, which should therefore be kept uppermost. After this stage every endeavour should be made to keep the cavity empty and promote free liberation of pus by postural drainage, begun as soon as the patient's general state will allow and persisted in despite the temporary discomfort and strain it may produce. This measure is of the greatest importance in treatment. The patient should be supported with head and shoulders over the side of the bed at least two or three times during

the day, and should try to empty the cavity by coughing. This is helped, and the offensive odour and taste lessened, by giving creosote, oil of garlic or guaiacol carbonate by mouth and by the use on a Burney-Yeo respirator of deodorant inhalations, such as creosoti 2 dr., ac. carbol 2 dr., sp. chloroformi 2 dr., tr. iodi. 1 dr., and sp. ætheris 1 dr., a few drops of the mixture being sprinkled on the pad every hour. A creosote chamber if available may be employed.

In addition to inhalations, when drainage is once begun the degree of infection of the lung cavity can be definitely lessened by intratracheal medication. Once or twice a week 20 cc. of warmed 10 per cent or 20 per cent gomenol in lipiodol is injected into the affected region of the lung, preferably through a gum elastic catheter introduced into the nose and passed by direct vision through the larynx well down into the trachea. This measure promotes coughing and exerts an antiseptic action on the infected air-passages. It is surprising how completely emulsified the oil becomes with the sputum, and patients volunteer their conviction of relief and greater comfort after its use. Cough is to be encouraged and all sedative drugs avoided. Some degree of continuous drainage is obtained by keeping the patient flat in bed and raising the foot of the bed eighteen inches.

Where the sputum contains abundant spirilla and spirochætes, organic arsenical preparations are of some value, e.g. novarsenobillon 0.3 gm. or arsphenamin intravenously weekly. Emetine and quinine are advocated by some but have no specific value.

In view of the long course of the illness, care must be taken to maintain the patient's nutrition, as far as appetite will allow, by good feeding with highly nourishing food. General tonics to aid digestion are of value.

The decision of the length of time that medical measures alone should be continued is no arbitrary one and will vary with the needs of the case. It has been pointed out that in the acute stage external surgical drainage is useless owing to the absence of localisation or line of demarcation between diseased and healthy tissue. In the majority of instances a minimum period of from 6 to 8 weeks should be allowed during which medical treatment should be pursued before resorting to surgery. A failure to improve and show signs of subsidence under postural drainage indicates a need for more active means of treatment. Where rupture altogether fails to occur, this will be needed correspondingly earlier. It is in cases of this type that bronchoscopy is indicated and is of great value. Its chief advantage is that the most natural route of drainage is employed.

If after about three weeks no sign of commencement of drainage is

forthcoming, an aspirating bronchoscope (fig. 1062) should be passed under local anæsthesia. A systematic search is made of the whole bronchial tree for the probable site of the abscess, as shown by local swelling with granulations of the entering bronchial wall. Where an escape of pus is seen, this is aspirated as completely as possible. More often the

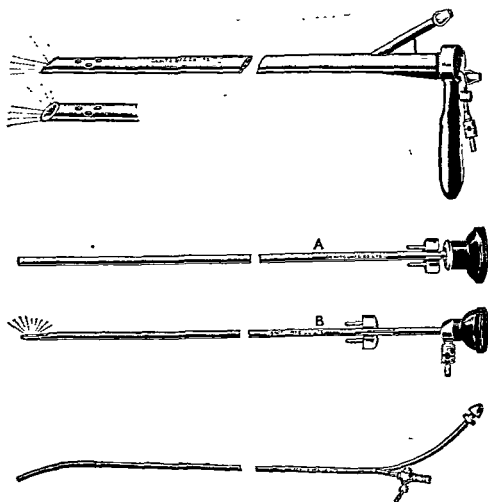


Fig. 1062.—BRONCHOSCOPIC APPARATUS (SCOTT FISCHER AND MORLOCK PATTERNS), WITH TELESCOPES, FORCEPS AND FLEXIBLE-ENDED SUCTION TUBE.

bronchus is blocked and no exit of pus evident. A fine flexible suction-tube is then passed into the abnormal branch, when pus may be released and removed. The suspected bronchus may, in a proportion of cases, be dilated and the obstruction to drainage thus relieved, while any redundant granulations are painted with 10 per cent silver nitrate solution or cauterised. Where no single bronchus suggests the location of the abscess, each of the smaller bronchioles is explored in turn with the suction-tube. This procedure may be repeated, as needed, on

subsequent occasions, and in the hands of experienced bronchoscopists a high percentage of cures thereby obtained both in acute and chronic cases. For the development of bronchoscopic drainage medicine is greatly indebted to the pioneer work of Chevalier Jackson in particular.

The proportion of cases of lung abscess submitted to bronchoscopy and the time that such treatment is instituted will vary in different hands. At the Victoria Park Hospital, Scott Pinchin and Morlock (6) were impressed with its value from the onset, finding that in nearly all their acute cases bronchoscopic drainage was followed by satisfactory healing and gave better results than general medical measures alone, while in a high proportion of chronic cases also the successes were greater and the mortality less than by employing surgical measures. They claim that in the majority of cases bronchoscopy is able to produce such results, in that by its means free drainage can be established. Abscesses in the upper lobe approached by an ascending bronchiole so far remain an exception as, although their position can be determined with a retrograde telescope, direct bronchoscopic exploration is prevented by their upward direction. Continued advances, however, in technique and in the construction of apparatus will probably result in such difficulties ultimately being overcome.

As described by the above observers, it is helpful at the onset of drainage after localisation of the abscess to obtain a precise record of its size and position, and essential should the need for surgery arise later. This is effected by taking antero-posterior and lateral X-ray pictures after the injection of a small amount of lipiodol direct into the abscess cavity through the bronchoscopic drainage-tube, the volume injected corresponding with the estimated size of the abscess. This method of bronchography is of value in following the progress of the case. At subsequent bronchoscopies, after aspiration of its purulent contents through a drainage-tube inserted and connected to an electric suction pump, the cavity is gently washed out with a small amount of antiseptic saline solution and from 10 to 20 cc. of 10 per cent gomenol instilled and allowed to remain. If spirochaetes are present in an uncontaminated specimen of pus removed for bacteriological examination, a solution of novarsenobillon 0.1 gm. may alternatively be instilled in an endeavour to disinfect the cavity.

In acute cases therapeutic bronchoscopy is repeated twice a week, it being found in their hands that an average of five treatments resulted in healing. In chronic cases, i.e. those persisting for longer than two months, many more treatments are needed, given at weekly or fortnightly intervals, the average number in their series being fourteen.

The authors conclude that by these means the necessity for surgical intervention can in most cases be avoided.

Where at the end of, say, three months' combined medical and bronchoscopic treatment no improvement is being effected, recourse must be had to direct surgical drainage. Attempts at collapse of the affected lung by artificial pneumothorax are advocated by some but should be sedulously avoided, being definitely dangerous. Collapse of the affected area of the lung is likely to be prevented by adhesions, while in any case closure of the walls of the abscess will neither be brought about nor maintained by pneumothorax unless rupture has already occurred into a bronchus; there is the chance that the patient's condition may on the contrary be made worse by obstruction from external pressure of any natural drainage already present. A graver risk is that of rupture externally into the pleura with development of a foetid pyo-pneumothorax and broncho-pleural fistula. The danger to life thereby is too great for a deliberate choice of this method to be advocated as a route of drainage of the abscess. A further danger of direct compression is dislodgement of infective material into the general circulation with resulting cerebral abscess. For like reasons phrenic avulsion usually fails to give relief or cure.

The methods of *surgical treatment* available are mainly two. In the great majority of cases, thoracotomy and direct drainage of the abscess will be the method adopted. In a few, it may be possible to remove the whole abscess-bearing area by lobectomy.

External drainage should be carried out as a rule in two stages. Endotracheal gas and oxygen plus a basal narcotic is the anaesthesia of choice, so that a positive insufflation may be obtained while the chest wall is opened. After accurate X-ray localisation, the affected area is approached by resection of a portion of the nearest overlying rib. In the case of an upper lobe abscess the incision may be made either in the upper part of the axilla or anteriorly through the pectoral region, while with a lower lobe abscess the postero-lateral aspect gives the best approach. The parietal pleura is then incised and inspection made for the presence or absence of adhesions of lung to pleura. If these are firm and dense so that the general pleural cavity is safely shut off, it may be permissible to complete the drainage in one stage. If no adhesions are found, the subjacent lung should be gently palpated, when usually the firm abscess-bearing area can be recognised. If further room is needed or the approach has not been quite exact, portions of the adjoining ribs may be removed. The affected area of the lung is then sewn to the parietal pleura all round the opening, or alternatively

packed with gauze to produce adhesions. Drainage is then left to a second stage, undertaken after about a week's interval. An exploring needle is gradually introduced into the consolidated zone until the abscess cavity is entered, when suction on the syringe produces a mixture of gas and foul blood or pus. The needle is then allowed to remain in position and the cavity opened along its track, either with a knife or the diathermy cautery. The use of the cautery minimises the dangers of distant metastasis, air-embolism and hæmorrhage. Alternatively, a director may be introduced by the side of the needle track and the wound enlarged with forceps, thereby avoiding injury to vessels. The cavity when opened is gently explored with the finger to break down any loculi, bleeding being usually but slight. To ensure complete drainage a portion of the roof and outer wall of the abscess may be cut away, and a large drainage-tube inserted leading out of the wound and lightly packed around with gauze. The margins of the wound are brought together by sutures on either side of the tube and gauze packing. The packing is removed within 48 or 72 hours of operation. Some surgeons advocate the use of gauze packing alone in the initial stage without insertion of a drainage-tube.

Where efficient drainage has been established, a rapid improvement follows in the patient's condition with subsidence of fever, steady diminution of sputum and of its foul odour, and eventual healing of the chest wound, in which a small drainage-tube should be kept until discharge is slight. The wound should appear healthy and free from offensive smell within a week. Irrigation of the cavity is not advisable because of the danger of leakage of the irrigating fluid into the bronchial tree and opposite lung.

In those cases where undue delay in surgical treatment has been permitted and the abscess has become chronic and thick-walled, or where a persistent sinus results, removal of a number of ribs may be necessary, i.e. a partial thoracoplasty in order to get the chest wall collapsed and the cavity obliterated.

Lobectomy should seldom be needed, being reserved for those rare, usually neglected, cases where the whole lobe has become grossly disorganised with secondary bronchiectasis. A preliminary phrenic avulsion may be indicated before the major procedure.

VI. POST-OPERATIVE GANGRENE OF THE LUNG

Always associated with septic aspiration, gangrene of the lung clinically resembles the picture of lung abscess, except that the degree

of illness and toxæmia is more acute and profound, and the chest signs more extensive and less clearly defined. With gangrene of the lung the nauseating foetor is, if possible, more marked than with abscess. The sputum is abundant, usually fluid, greenish-brown in colour from broken-down blood, and contains shreds of soft, pulpy lung tissue in which, on microscopical examination, elastic fibres may be identified. In some cases quite large fragments of shaggy, necrotic lung tissue may be coughed up; hæmorrhage may be abundant, some degree being always present. So characteristic are the features of the sputum in gangrene of the lung that from its examination alone little doubt remains as to the diagnosis.

The extent of the pulmonary lesion is wider than in abscess, being often formed of multiple areas of patchy gangrenous broncho-pneumonia. The X-ray appearance shows a diffuse zone of dense opacity due to consolidated lung with perhaps a number of separate clearer areas of breaking-down tissue, the characteristic fluid level of lung abscess not being present. Where diffuse or multiple areas of gangrene are present, the prognosis is extremely bad and surgery of no avail. Treatment is on medical lines as for lung abscess; search for a possible foreign body, free administration of stimulants and maximum promotion of drainage are of greatest importance. Where only a localised area of gangrene is present an attempt should be made at surgical drainage and excision of the sloughing tissue.

VII. PLEURISY

As a post-operative complication pleurisy has no special features of its own and is seldom primary, being usually an expression of spread to the surface of the lung of an inflammatory condition deeper in its substance, as already described, whether due to collapse, pneumonia, infarction, abscess, or gangrene. It is frequently the responsible factor in bringing the main lesion under observation, either by pain in the chest or by physical signs. According to the severity of infection it may remain fibrinous or progress to a serous or purulent effusion. In addition, pleurisy may arise after abdominal operation by a direct upward spread of infection through the muscular substance of the diaphragm, or extra-peritoneally from the peri-renal cellular tissue, its distribution being commonly over the thoracic aspect of the diaphragm and the adjoining lung base. Frequently it may remain dry or fail to progress beyond a scanty sterile serous effusion.

The *treatment* of the pleurisy will be that of the underlying condition, while the management of an empyema will be indicated by its circumstances.

VIII. AFFECTIONS OF THE MEDIASTINUM

Acute mediastinitis, or cellulitis of the mediastinal connective tissue, is an uncommon complication of operations on infective conditions of the mouth, neck, larynx, and trachea or œsophagus, whereby sepsis tracks down the cellular planes, e.g. from a deep cervical abscess, into the chest. Occasionally, the mediastinum may become infected by direct spread from the chest wall, lung or pleura, as from lung abscess or empyema. Suppuration ensues, and the pus may track widely in different directions and open into any adjacent organ or cavity.

The symptoms and signs are often inconclusive. Besides marked general illness, severe pain is felt beneath the sternum spreading to the interscapular region, with development of symptoms and signs of pressure if the inflammatory swelling becomes of any size and involves the posterior mediastinum. There is paroxysmal cough, hoarseness, dyspnoea and stridor, and sometimes dysphagia. Cyanosis with venous engorgement of the neck and upper limbs develops, with perhaps an inflammatory œdema of the chest wall. Diagnosis is made on the above signs and symptoms and on the acuteness of development, thus excluding the more common causes of chronic mediastinal pressure. A skiagram may give confirmation by showing an abnormal localised shadow.

The prognosis is very serious, as the condition is not amenable to treatment unless the ensuing abscess should point externally in the neck, when it may be drained. Frequently death results within a few days from extension or rupture into vital organs, or may precede the formation of any well-defined abscess.

Acute œdema of the larynx, although not strictly a thoracic complication, is a serious sequel that may follow the giving of an anæsthetic (especially nitrous oxide) for an operation for cellulitis or septic condition of the face, neck or throat. The patient, frequently a child, is suddenly seized with dyspnoea, accompanied by hoarseness and stridor, which if unrelieved rapidly progresses to asphyxia. The cause of the obstruction is an acute œdematous swelling of the epiglottis and aryteno-epiglottidean folds. In severe cases an emergency tracheotomy will be needed, but milder grades of obstruction may be relieved by ice-cold compresses or an ice-bag to the neck, ice to suck, spraying the larynx with 1/1000 adrenalin solution and scarification of the epiglottis.

Acute interstitial or surgical emphysema may be briefly mentioned as a complication sometimes seen after operation on the upper air-passages or chest. It results from an artificial communication between the lining membrane of the air-passages or parenchyma of the lung and the cellular tissue of the neck, chest wall or mediastinum, and may follow such a simple procedure as introduction of an exploring needle into the chest or a cannula into the trachea. It is more likely to develop where no open route of escape of air through the skin is present. Usually trivial and no more than a localised tender area of subcutaneous swelling and crackling, rarely it may become alarming, air being forced into the subcutaneous connective tissues with each expiration until the whole body may become blown up like a balloon from scalp to feet, the features being bloated and unrecognisable. Much pain and discomfort is then present, and danger may arise from dyspnoea and respiratory obstruction if the larynx becomes involved by direct spread, when tracheotomy may be called for. Breathing may also be hampered by distension with air of the tissues of the posterior mediastinum.

Nearly always, absorption of air is rapid and no special treatment required. Suppression of cough and local pressure, e.g. on the chest wall, may check the spread. Where the subcutaneous involvement is becoming generalised, and the site of entry of air is accessible, as over the trachea, direct open incision should be made down to this level so that the air has a free means of escape. It is emphasised that such a circumstance will be rare.

IX. LATE PULMONARY EFFECTS

(a) *Exacerbation of previous disease*

The giving of a general anæsthetic may light up or exacerbate old-standing disease in the lung, in particular a focus of pulmonary tuberculosis. Hyperæmia, irritation of the mucosa and aspiration of secretions into other parts of the lung are chiefly responsible. Within a few days or weeks there is unexplained fever and illness, with appearance of fresh and persistent physical signs, while the subsequent course of spread is apt to be rapid. Every care, therefore, should be taken not to overlook pre-existing phthisis, although quiescent, before giving a general anæsthetic, while if evidence is found ether should be studiously avoided. Where suitable, spinal anaesthesia should be given, alternatively gas and oxygen with or without a basal anæsthetic. A similar danger, also requiring care in anaesthesia, is that of infecting a previously

clean "dry" case of old-standing or congenital bronchiectasis, a risk especially liable to occur during operative treatment of acute septic conditions in the nose or sinuses.

(b) *Fibrosis and bronchiectasis*

The danger of residual scarring of the lung, and its accompaniment of a septic infection and dilatation of the bronchi, has already been discussed. Attempts to avoid such sequelæ should be made by assisting in every way the resolution of inflammatory areas and by adequate bronchial drainage.

X. POST-OPERATIVE CARDIO-VASCULAR COMPLICATIONS

(a) *Shock*

Despite the great amount of investigation carried out on this subject, the question of shock still remains a problem of the first importance. It is not intended here to enter into any theoretical consideration of its various causes, but rather to review briefly those practical aspects of its prevention and treatment which concern the surgeon.

The clinical symptoms of shock need no detailed description in this article. Pathologically, they follow primarily from a reduction in the volume of circulating fluid, in which capillary dilatation and paralysis play the chief part, with resulting inadequate return to the heart and fall of systolic blood-pressure. Because of this capillary stasis, the peripheral blood becomes concentrated by loss of its fluid elements and may actually show a raised hæmoglobin and red cell content.

The chief factors known to dispose to post-operative shock include age ; loss of blood ; exhaustion from pain ; cold and exposure ; and surgical trauma.

Surgical shock is most likely to occur in infancy and in the aged. Loss of blood, whether before operation or at the time, is perhaps the most outstanding immediate factor in its production. The volume of circulating fluid, already depleted by capillary stasis, is further reduced by direct hæmorrhage and embarrassment of the heart accentuated. Pain increases nervous fatigue and, together with mental anxiety, leads to exhaustion and shock.

The temperature in shock is already sub-normal from a rapid loss of heat and lowered metabolism, and any further fall by unnecessary exposure or chill will increase its degree.

Surgical trauma tends to lead to shock in two ways. In the first place, any damage or laceration of tissues is accompanied by the

liberation into the blood stream of a toxic histamine-like substance, which by its action on the capillary tone causes stagnation and fall of blood-pressure. Secondly, from stimulation of exposed nerve-endings in areas richly supplied, a direct depressant effect on the vasomotor centre is produced, accentuating the drop in pressure.

Measures of prevention and treatment will follow from consideration of these factors. Hæmorrhage must be promptly and completely controlled. If direct loss is a predominant factor in the case, transfusion of blood before, during, or after operation may be indicated. Pain is prevented by adequate doses of analgesic drugs, among which morphia is generally indispensable; it should, moreover, be used freely. Measures must be taken to prevent any avoidable loss of body heat during operation or afterwards by heating of the theatre and its approaches and by sufficient clothing, while in the presence of shock warming of the patient by hot-bottles, radiant heat or an electric blanket is invaluable. As regards surgical technique the more gentle the handling of viscera, even under anæsthesia, and the less prolonged the operation within reason, the less the ensuing shock. Blocking of nerve trunks by local anæsthesia diminishes the factor of reflex nervous inhibition of the medullary centres. Where shock is already present or anticipated, the most satisfactory anæsthesia is gas and oxygen.

In treatment, the measure of outstanding importance is restoration of the circulating blood volume. Fluid is given in the greatest possible quantity by mouth and by rectum, the latter usually being retained if given as a slow continuous drip in saline by the Murphy method. Where shock is severe the intravenous route must be employed. Infusions of saline, either normal or hypertonic, may be given, to which glucose 5 per cent may be added. With suitable apparatus a warmed continuous intravenous drip infusion may be given of saline or Ringer's solution, tying in the needle, and many pints introduced thereby during the 24 hours. Where single injections are made, it is advantageous to use a 6 per cent gum-arabic solution in normal saline to ensure longer retention in the circulation. Preservation of the vital centres is aided by lowering the head.

Drugs are of subsidiary importance if morphia be excepted, but restoration of blood-pressure is aided by subcutaneous injections of pituitrin $\frac{1}{2}$ -1 cc., or adrenalin 5 minims and of ephedrine hydrochloride 1 gr. intramuscularly.

(b) *Myocardial failure and dilatation*

It has been pointed out that the condition of shock commonly met with after operation is due to a failure primarily of the peripheral

circulation rather than of the heart itself. In a less common group, the central organ is at fault, circulatory disorder resulting from insufficiency and dilatation of the myocardium.

Such an event is of more frequent occurrence in the obese and elderly patient with a fibroid or fatty degeneration of the heart. The added strain of operation and the disturbances of circulation inseparable from anaesthesia combine, with shock and hæmorrhage, to produce failure, which may be shown in several ways. The pulmonary side usually suffers; distension of the right chambers are shown by cyanosis, engorgement of veins in the neck and pulsation in the epigastrium. Signs of passive congestion of the lung bases develop with dyspnoea, short paroxysmal cough and frothy mucoid sputum, or perhaps a right-sided hydrothorax and hepatic engorgement. The ease with which in a feeble bedridden subject hypostatic basal congestion passes on to a hypostatic pneumonia has already been mentioned, and is an indication to shift the position periodically from side to side and to encourage deep breathing.

Rarely, the complication of acute pulmonary oedema may be met with after operation, even after the simple giving of gas to an aged feeble patient. A sudden flooding of the pulmonary alveoli with thin, watery serous exudate occurs, it is thought, from dissociated action of the two ventricles and relative enfeeblement of the left. There is intense oppression, pallor, and dyspnoea with violent respiratory effects and copious gushes of frothy fluid, sometimes blood-stained, from the nose and mouth. The breath sounds are weak, with copious bubbling râles all over the chest. The prognosis is serious, but recovery may follow the administration without delay of morphia $\frac{1}{2}$ gr. and atropine $\frac{1}{100}$ gr., combined with venesection.

In other instances, the general slowing of the circulation after operation and fall of blood-pressure may result in thrombosis of a branch of the coronary artery with its characteristic syndrome and resulting cardiac failure, usually in the elderly male patient. Failure, again, may follow disturbance of rhythm, especially the onset of auricular fibrillation. Attacks after operation of cardiac asthma or of Cheyne-Stokes respiration, apart from the more obvious phenomena of a failing left ventricle, should direct attention to the heart.

Finally, the heart may become involved by a spread of infection to the pericardium, either directly from a neighbouring structure or from a septic embolus. Infective endocarditis is again a rare post-operative complication in a case of severe septic infection. Either of these localisations in the heart is usually terminal and fatal.

Treatment of Acute Heart Failure. Absolute rest and skilled nursing are the essentials of treatment. A bed-rest will enable the patient to recline at the most comfortable angle. Anxiety and mental distress must be allayed and sleep obtained. The milder sedatives such as chloralamide and bromide and drugs of the barbitone group usually fail to give rest or relieve the dyspnoea. Paraldehyde is often more effective and worth a trial, but in most cases morphia $\frac{1}{4}$ gr. or heroin $\frac{1}{8}$ gr. is needed, given always with atropine $\frac{1}{16}$ gr. to minimise basal oedema and congestion. No other drug is so effective in cardiac failure.

Digitalis in adequate dosage should always be given, the amount required depending on the degree of failure and urgency of the symptoms. With auricular fibrillation massive doses of the tincture are indicated, e.g. 3-4 dr., during the first 24 hours, but with less acute failure and a normal rhythm doses of 20 minims 6-hourly generally suffice. With this dosage saturation will usually be reached within 3 days, when a reduction will be needed according to the pulse rate. If vomiting is present the drug may conveniently be given as Nativelle's digitalin granules $\frac{1}{10}$ gr. or $\frac{1}{20}$ gr., equal respectively to 15 or 6 minims of the fresh tincture. Guy's pill is also valuable and reliable, containing a grain each of pulv. digitalis folia, pulv. scillae and pil. hydrarg, and equal in effect to about 15 minims of the simple tincture.

With urgent failure strophanthin $\frac{1}{10}$ - $\frac{1}{20}$ gr. given intravenously is equally reliable and more rapid in its effects. If digitalis has already been begun, it is better avoided in view of the danger of cumulative action. A valuable and safe method is to give three divided doses of ouabaine (strophanthin-G) $\frac{1}{10}$ gr. intravenously at intervals of half an hour. The drug cannot safely be repeated for 12 hours after full dosage.

If digitalis fails, usually other cardiac stimulants fail also. Diuretics such as theobromine sodium salicylate 10-20 grs. t.d.s. may help to increase the output of urine. Where applicable, purgation by calomel and salines will lessen oedema and relieve the heart. With engorgement of the venous circulation venesection is indicated, half to one pint being removed from the elbow, but in left ventricular failure the benefit is slight. Dry cupping of the lung bases or application of leeches over the liver is often of value, though the mode of action obscure. Mechanical drainage of a hydrothorax is indicated if by its pressure it is producing further embarrassment of the heart.

Other rapidly acting stimulants which may be given in acute post-operative cardio-vascular failure include liq. adrenalin 1/1000 5 minims subcutaneously, of great value with a low blood-pressure, though only

temporary in its effect and needing to be repeated at 4-hourly intervals. Given as an injection of 1 cc. directly into the heart it is the most valuable remedy we possess to combat cardiac arrest under anæsthesia.

Strychnine is a vasomotor rather than a cardiac stimulant and is useful under similar conditions, giving, say, $\frac{1}{60}$ gr. hypodermically at intervals of 6 to 8 hours. Camphor 3 grs. in sterile olive oil 1 cc. or coramine 1 cc. intramuscularly may similarly be helpful stimulants. In pure cardiac failure oxygen is disappointing in its effects unless definite respiratory affection is present, when it should always be given.

In the presence of failure, care must be taken not to overload the circulation by giving more volume of fluid than it can accommodate, evidenced by œdema, although any severe restriction of intake after operation is unwise. Reference has already been made to the value of glucose as a cardiac stimulant, given with the feeds as well as intravenously where indicated. Alcohol may aid digestion and be a valuable sedative and food. The diet should be appropriate to the digestive powers and appetite, and consist of frequent feeds with a high milk and carbohydrate basis.

In any case where cardiac failure has been present, convalescence must be correspondingly gradual, rest being enforced until all evidence of œdema, venous engorgement or pulmonary congestion has cleared.

PREVENTION OF POST-OPERATIVE CHEST COMPLICATIONS

It may be helpful, after separate consideration of the more frequent chest sequelæ, to co-ordinate the subject in a review of the various factors in causation and of the means of prevention which they share in common.

(1) *Age, Build, and Previous Disease*

The added susceptibility to these complications in general at the extremes of life has been mentioned, together with the predisposing influence of previous chest disease, obese habit or debility from any cause. Over these factors there is from their nature no control.

(2) *Type of Operation*

The overwhelming preponderance after abdominal operations has been noted, especially after interference in the neighbourhood of the diaphragm, the complications mainly concerned being pulmonary collapse and broncho-pneumonia. The frequency of lung abscess after operations on the upper air-passages has also been emphasised.

(3) *The Factor of Impaired Respiratory Expansion*

It has been shown that interference with the free ventilation of the lung bases is the most important single factor leading to subsequent trouble in the chest. Such inhibition of breathing may be associated with a variety of causes, which are enumerated below, together with the means of their prevention.

(a) *Trauma to the diaphragm.* The predominating importance of disturbed function of the diaphragm leading to pulmonary collapse and broncho-pneumonia has already been stressed. Damage to the structures immediately subjacent is accompanied by a reduction in vital capacity by half, sometimes considerably more, its effect being increased by the presence of sepsis. The necessity is therefore clear for the greatest care and gentleness in handling of viscera, and a reasonable rapidity of surgical technique. Bruising and tearing of tissues by "blunt dissection," and stretching of incisions by the use of heavy wide retractors are to be avoided, in view both of the local damage they produce and of the liberation into the blood stream of thrombo-kinase predisposing to thrombosis. Excessively large incisions, especially if accompanied by injury or division of intercostal nerves or muscle structure, are a similar handicap to respiratory movement.

(b) *Drugs which depress the respiratory centre.* Care is needed in the use of powerful narcotic drugs with a strong affinity for the respiratory centre, both before and in the period immediately after operation. Morphia and heroin should be given cautiously, and large doses where possible avoided. They should be withheld at any rate until there is complete recovery of consciousness, for suppression of cough in this phase will prevent the expulsion of any secretions which have collected in the bronchi during operation. The use of morphia cannot usually be dispensed with on the night after operation, but thereafter an attempt should be made to substitute for it sedative and analgesic drugs less depressant to the respiratory centre. The use of atropine $\frac{1}{32}$ – $\frac{1}{16}$ gr. before operation, and subsequently in repeated smaller doses, is of value in stimulating the centre and preventing excessive bronchial secretion. Later, the giving of expectorants such as potassium iodide and ammon. carbonate helps to keep the lung bases clear.

While basal narcotics are of the greatest value in minimising the requirements of volatile anæsthetics and so protecting the lungs from direct irritation, care is needed in selection of cases and gauging of dose, for their indiscriminate use may be followed by undue depression of the respiratory centre.

(c) *Mechanical constriction.* The adoption of abnormal postures and their maintenance during a lengthy operation may mechanically interfere with expansion of the lung bases, as by the disposition of heavy sand-bags under the body in gall-bladder or renal operations. Later, constriction by tight bandages or abdominal binders will similarly embarrass the breathing. Dressings should, therefore, be loosened and adjusted periodically as needed for the patient's comfort. The posture adopted after operation, moreover, should be such as will allow free movement of the diaphragm—the Fowler's position with a suitable firm bed-rest will permit the greatest degree of expansion and avoid the upward pressure of the liver and abdominal contents on the diaphragm. A frequent change of position and encouragement of movement in bed and early sitting-up will assist free aeration, together with breathing exercises and massage. Distension of the abdomen by tympanites is to be guarded against, and treated energetically from its appearance by the usual methods; the recent use of choline compounds has proved of value in this respect.

These measures not only aid ventilation of the lungs but also indirectly promote an adequate venous return and lessen the liability to thrombosis. Daily movements and massage of the lower limbs serve in the same way.

Special emphasis must be laid on the great value of *carbon dioxide gas* both as a prophylactic and a therapeutic measure in post-operative chest complications, through its physiological action as the normal stimulant to the respiratory centre. It has an appropriate place during each phase of the operation cycle. During the stage of anaesthesia, the depth of breathing may be so adjusted as to maintain a full degree of pulmonary ventilation. At the end of the operation the unwanted period of anaesthesia can be shortened and early recovery of consciousness assisted by artificial hyperpnœa, five to ten minutes usually being sufficient. An early return of cough reflex enables the bronchi to be cleared of accumulated secretions, retention of which is the main predisposing factor in subsequent infection. Volatile anaesthetics are "washed out" of the circulation via the air-passages, shortening their irritant action on the bronchi and avoiding unnecessarily prolonged depression of the respiratory centre.

A supply of carbon dioxide should, therefore, be part of the standard equipment of every surgical ward. Routine inhalation of a CO₂ and oxygen mixture, 5 to 10 per cent, for short periods of about 5 minutes at intervals of 4 to 6 hours during the first two days, or longer, after operation is a valuable safeguard against serious chest sequelæ, by maintaining

an adequate depth of breathing and preventing the accumulation of viscid obstructing secretions in the bronchi. If not employed in every case, it should certainly be given to any patient whose colour is poor or breathing shallow.

As a measure of treatment CO₂ inhalation is of similar value, though needing to be given in greater concentration and for longer periods, as already described under "Pulmonary Collapse."

(4) *The Factor of Pre-existing Infection*

The presence of potentially pathogenic organisms in the upper air-passages prior to operation constitutes an ever-present danger of downward spread of infection to the lungs when their vitality and powers of resistance are lowered by anæsthesia, and the soil prepared by stagnation and shallow breathing. Bronchitis, collapse of the lung, broncho-pneumonia and the more serious sequelæ of pulmonary suppuration and gangrene are all rendered more likely of occurrence, as is also distant venous thrombosis.

Wherever possible, therefore, preliminary attention should be given to the condition of the mouth and throat. Pyorrhœa should be treated, loose septic teeth or infected tonsils removed, and an attempt made to clear up any nasal or sinus infection. Any non-urgent operation should be postponed in the presence of a coryza, bronchitis, or recent catarrhal illness or cold foggy weather.

(5) *Chill and Exposure*

Similarly, with a fall of body temperature there is a progressive lowering of resistance to infection. During anæsthesia the normal heat-regulating mechanism is in abeyance, while in addition there may be much loss to the body by evaporation, especially with a long open-ether operation. It is therefore of the greatest importance to maintain the body temperature both during and after operation by warm clothing and footwear, covering those parts not needing to be exposed, while the theatre and ward are suitably heated and the distance of transit from one to the other reduced to a minimum. The building of the theatre on the same floor and immediately adjacent to the ward is ideal in this respect. As regards operative technique, again, unnecessary loss of heat can be prevented by the warming of instruments and protection of exposed viscera from chill by hot packings.

(6) *The Prevention of Septic Aspiration—Choice and Technique of Anæsthesia*

Detailed consideration of the choice of anæsthetic for particular operations is given elsewhere in the special section dealing with that subject. It is therefore discussed here only from the standpoint of its relation to chest complications. Undoubtedly, of general anæsthetics ether exerts the most irritant effect upon the respiratory passages, and the chest is most protected if its use and amount can be reduced to a minimum. Even when given indirectly as a rectal-oil administration this irritant factor is not altogether overcome, as the drug has to be excreted by the alveoli. When ether anæsthesia is desired the production of mucus is reduced by giving atropine before induction. Any impurity in the ether will increase its irritant effect, as will excessive concentration or incorrect temperature of the vapour.

The ideal general anæsthetic for major surgery from the thoracic point of view is nitrous oxide and oxygen, supplemented where necessary by a basal narcotic such as avertin or nembutal, which has the added merit of calming the patient before operation. For short general anæsthesia, e.g. rib resection for empyema drainage, opening of abscesses, tooth extraction, intravenous evipan is of great value and easy of administration. The use wherever possible of local anæsthesia, either alone or as a supplement to general anæsthesia by nerve or regional blockage, is a further safeguard.

It is seldom possible to prevent some increase of bronchial secretions, but by appropriate technique of anæsthesia they may be removed as formed and prevented from accumulating in the respiratory passages. One of the most important factors is that of posture. It has been pointed out that the danger of aspiration of infective material into the lungs is greatest with operations on the mouth and upper respiratory passages, these having the highest incidence of subsequent lung abscess. Infective blood, pus, sputum or vomit, or an actual foreign body such as a tooth, portion of tonsil or adenoid, gauze, swab, or plugging may be sucked down into the air-passages by a deep inspiration past the insensitive larynx. The risk is obviously much greater in the sitting position, which is therefore to be avoided. In all such operations, e.g. tonsillectomy, the head should be kept lower than the rest of the body, as in the Trendelenburg or Rose positions, so that any foreign body falls not into the larynx but into the naso-pharynx or pharynx. In some cases raising the shoulders on a sand-bag and allowing the head to hang down backwards will suffice. The endotracheal route of

anæsthesia should be used for all mouth, throat, and nose work in the adult, as for all operations on the chest. In the latter instance it has, incidentally, the further advantage that positive pressure insufflation may be employed when needed, e.g. on opening the pleura. By using an endotracheal catheter with return air-way, the pharynx can be protected by gauze packing, as advocated by Magill, and blood and secretions removed by continuous suction through a gum elastic catheter passed into the naso-pharynx through the nose. In this way clots of blood will not be allowed to collect in the nose and pharynx to be subsequently inspired. Nasal plugging is, of course, to be securely fastened outside the nose. At the end of the operation the pharynx is seen to be dry before the patient is returned to his bed, and thereafter he is kept on his side with the foot of the bed raised until recovery of consciousness. The use of CO₂ to promote hyperpnœa would not be free from risk unless the upper air-passages were known to be free from blood clot.

Tonsillectomy is not commonly performed under local anæsthesia in this country. Where so carried out it is important to maintain as far as possible the sensitivity of the larynx by avoiding the trickling down of cocaine solutions, so that blood or pus is coughed up or swallowed rather than inhaled.

Other general points of anæsthetic technique in prevention of septic aspiration are a maintenance of the correct degree of anæsthesia, and especially the avoiding of violent struggling or straining movements, vomiting, deep cyanosis or stertorous breathing during which mucus or saliva are inhaled into the lungs by the sudden efforts of inspiration.

(7) *Maintenance of Body Fluids and Circulation*

Finally, the need has been mentioned of ensuring a sufficient volume of circulating body-fluid by giving abundant fluids before and after operation, avoiding strong purging and starvation beforehand with their accompanying weakness, and prompt arrest of direct loss of blood at operation. In these ways the risks of shock, collapse and subsequent venous thrombosis and embolism are minimised, while after operation massage and early movements are a further aid in preventing venous stasis and maintaining a normal circulation.

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CHAPTER II

ARTIFICIAL PNEUMOTHORAX

ALTHOUGH of recent years the range of useful application of collapse therapy and especially of artificial pneumothorax has widened, it is still in the treatment of pulmonary tuberculosis that it finds its most general indication.

The use of collapse therapy in this regard involves no fresh principle of treatment, being but a special application of the fundamental need for obtaining the maximum degree of rest for the diseased area wherever it may be. In the case of the lung the intrinsic difficulty is a mechanical one arising from its normally continuous expansile movements with respiration.

In health there exists between the two contrasting surfaces of the lung a difference of pressure which prevents it from collapsing. As long as the pressure in the pleural cavity remains at a lower level than that in the air-passages, and the difference is sufficient to overcome the natural elasticity of the alveolar tissue, the lung follows the movements of the chest wall and expands with inspiration. If, by introducing from without a splint of air into the pleural sac, these pressures are equalised, the lung undergoes complete collapse into an immobile airless structure lying centrally against the mediastinum, provided that it is not prevented from doing so by adhesions or other circumstances. It is upon this mechanism that the principle of pneumothorax treatment is based.

Artificial pneumothorax is but one aspect of the treatment of pulmonary tuberculosis, and in no sense is to be claimed as a cure, although when properly employed it undoubtedly reduces the risks and mortality of the disease. Its use does not in any way lessen the need for general care and supervision and the customarily accepted regime of hygienic measures.

Since the disease was first recognised the number and variety of special modes of treatment, for the results of which substantial or extravagant claims have been made, is legion. Each has had its vogue

and for the most part initial enthusiasm has waned or been discredited. The most searching test of the value of a line of treatment is time. Judged by these standards collapse therapy is fully established. Its possibility first conceived over a century ago from recognition of the benefit which often follows a spontaneous pneumothorax, during the past two decades it has found steadily increasing application. So much so that in the writer's opinion it is at the present day in danger of suffering in repute from a too liberal interpretation of its possibilities. Nevertheless, given adequate care in assessment and choice of case, its value is fully accepted by the experienced observer. The wider one's experience of tuberculosis the more sceptical does one become of statistics. Supervision, however, of a large pneumothorax clinic leaves one in no doubt, from a study of the individual case, of the value of the treatment and of the altered outlook on the disease it has produced.

Pneumothorax does not constitute the sole available means of inducing pulmonary collapse. The possible need must be borne in mind, either as an alternative measure or to supplement the effects of pneumothorax at a later stage, of such surgical means of collapse as phrenic avulsion or thoracoplasty. The best results are only to be obtained by a co-operation of medicine and surgery, and by a correct decision, which experience alone can give, of when and where to employ each method.

INDICATIONS IN THE TREATMENT OF PULMONARY TUBERCULOSIS

In selecting a case for pneumothorax two primary factors have to be reviewed which are usually interdependent—the degree of activity and the degree of fibrosis. In general, the greater the evidence of toxæmia and the less that of tissue response the clearer is the indication for pneumothorax treatment, if not excluded by distribution of the lesion. With chronic fibroid disease, on the other hand, pneumothorax is not likely to be successful because of adhesions to the chest wall and an inability of the fibroid lung to collapse. If collapse therapy is indicated in this type of case the methods to be adopted are surgical. The acute febrile case with wasting and positive sputum is then, for choice, the type for pneumothorax, and ideally so if the disease be strictly unilateral. If both lungs are involved, then decision must rest with the individual case, as considered later. It is unnecessary to point out the danger of interpreting the absence of physical signs on the opposite side as absence of disease—a careful X-ray is always necessary.

(a) *Indications in Unilateral Disease.* The most clear-cut indication then for pneumothorax is the acute exudative or ulcerative form with unilateral involvement met with most frequently in the adolescent or young adult patient, especially in girls after puberty. It is in such cases that the most dramatic and satisfying results are obtained. The disease process is one of rapidly spreading, broncho-pneumonic infiltration breaking down into caseous areas and forming ragged soft-walled cavities, the absence of resistance being shown by the lack of any attempt to wall off the infection by a protective barrier of fibrous tissue. The rapidity with which such cavities develop and grow is not generally realised, and is to be measured in terms of days rather than weeks. In such instances the need for collapse is nearly as urgent as is surgery for an abdominal emergency, so rapid is the tendency for the disease to become bilateral in the absence of collapse. The favourable effects of pneumothorax in such a case following successful collapse are seen in a diminution or disappearance of fever and toxic symptoms, with coincident gain in weight, improvement in general condition, and lessening or abolition of cough and sputum, as the closure occurs of air spaces and cavities in the lung. With effective collapse the soft-walled cavities are in this stage capable of complete healing, leaving on subsequent re-expansion of the lung merely a puckered scar, sometimes only just visible in the best X-ray. Lymph-stasis and passive hyperæmia in the collapsed lung and the complete cessation of movement are other factors aiding its healing and improving the chance of recovery.

In the fulminating form of a true lobar or caseous tuberculosis, which is surprisingly often unilateral, attempts at collapse, though even more desirable, are not infrequently frustrated by the firmness and solidity of the lung. The confluence of the caseous areas causes loss of all elasticity, and attempts at the introduction of air merely bring about displacement.

In less acute disease some degree of pleural adhesion does not necessarily prevent a good functional result, but in the above types of case the collapse to be effective in holding the disease must be complete.

It is admittedly true that early chronic unilateral phthisis may heal on a regime of rest and prolonged sanatorium treatment alone. On the other hand, many such cases do continue to spread slowly in spite of complete rest. It was previously the custom to lose a considerable and valuable period of time, e.g. up to six months, in awaiting response to sanatorium and other modes of treatment, finally inducing a pneumo-

thorax on the advanced case when these methods had failed. The longer the delay, however, the more likely are adhesions to form and prevent an efficient collapse later, while cavities extend and become permanent with thickened unyielding walls. At this later stage also the more fibrotic cavity wall is not only less likely to collapse, but even so is more liable to re-open in the critical stage of re-expansion when pneumothorax is terminated. Moreover, with a persistent cavity and positive sputum eventual spread to the opposite lung is an ever-present danger, and one which in the acute case is very great.

The final prognosis and ultimate result of pneumothorax treatment is therefore very largely dependent upon a correct, and especially an early enough, choice of time. It is unfortunately a commonplace still to see in hospital out-patient work large numbers of cases with neglected histories and frank bilateral disease. The conclusion is inevitable that if diagnosed at an earlier stage a definite proportion of these cases would then have been fit subjects for collapse therapy. The writer therefore strongly disagrees with the view often stated that only from 2 to 5 per cent of cases of pulmonary tuberculosis are suitable for pneumothorax treatment.

If collapse therapy is to be given a trial at all in a given case, it should on these grounds be used early. With modern facilities the dangers are small. Even if unsuccessful the patient is none the worse off for the attempt, for the step is not irrevocable as with a thoracoplasty. Especially is early use of pneumothorax to be advised where the patient is either unable or unwilling to devote months or years to sanatorium treatment, or where he will not submit to the discipline involved. Frequently with an efficient collapse he can be rendered fit to resume and continue his employment at a much earlier stage than without such interference, and breakdown is less likely to result from overwork or indiscretions of living.

Any unilateral case, therefore, in early adult life, in which, with a persistently positive sputum and clinical evidence of activity, a month's absolute rest in bed fails to bring about complete subsidence of fever and clearing of the extent of infiltration in comparable serial skiagrams, or on the contrary is accompanied by a spread of disease, should be submitted to an attempt at collapse by pneumothorax. Especially is this the case if recent cavitation is present. Again, the younger the patient and the greater the degree of fever and toxæmia the more urgent is the collapse and the shorter the preliminary period of observation should be.

In the type of unilateral case, also, in which although with

complete rest the patient remains afebrile, yet no reserve remains, and with getting up or slight exertion fever again returns, pneumothorax should be induced. With the affected lung collapsed and immobilised many patients of this class will be able to earn a living and even lead a fairly active life, and in any case the risk of breakdown is reduced.

Even if after sanatorium treatment recovery of stability and health is regained, but the sputum remains positive, or large cavities and abundant sputum persist, collapse by pneumothorax should be attempted in the first place. The final results after a period of years between T.B. positive and T.B. negative cases is so striking that every attempt should be made to abolish the tubercle bacilli from the sputum, and a pneumothorax may turn the scale in this regard. Two dangers may be averted—that of spread and that of conveying infection to others. It may be possible by this means to certify the patient free from tubercle bacilli, as is often required before resumption of work is allowed. Moreover, although the pneumothorax obtained be only partial (as with a large cavity is not unlikely) it may be possible by subsequent division of adhesions to convert it into a complete collapse.

Similarly, the case which after initial success of hygienic treatment has a relapse with recrudescence of activity in the affected lung and spread of infiltration should be submitted to pneumothorax.

A further indication in the unilateral case is severe or repeated hæmoptysis. It is not possible as with hæmorrhage elsewhere to apply direct pressure, but collapse of the diseased area will often allow the affected vessel to retract, and is therefore the most logical form of treatment to arrest the bleeding. With copious hæmorrhage not subsiding with rest and morphia, provided that the affected side is known, the lung may be smartly collapsed without the need for refinements in grading the amount of air. Often only a partial collapse may be needed. Rarely the hæmorrhage may be arrested by partial collapse of the opposite lung, if adhesions prevent collapse of the side of the bleeding.

When small hæmoptyses recur at frequent intervals and interfere with the patient's occupation their occurrence may be arrested by a pneumothorax. The indication here is not so much to prevent blood loss as to minimise the risk of spread by aspiration of infected blood.

Tuberculous laryngitis is always due to direct infection by the passage over the larynx of tubercle bacilli-laden sputum. The removal

by collapse of the lung of the source of supply frequently leads to healing, and pneumothorax is therefore indicated rather than the reverse. The resulting diminution of cough likewise gives more rest to the diseased larynx. The complication of definite abdominal tuberculosis, usually ulceration of the ileum, contra-indicates treatment—diarrhoea due only to toxæmia not so.

In phthisis complicated by pregnancy which has already passed the 16th week little is gained from operative termination, and if the disease is unilateral pneumothorax should be induced without delay. Such cases will go through the whole of pregnancy and labour without added difficulty and the serious risk of breakdown in the puerperium is minimised.

In some cases of tuberculous pleural effusion where clinical symptoms and a skiagram show evidence of disease in the underlying lung parenchyma also, it is correct treatment to replace the fluid by air and to maintain a pneumothorax. If the effusion were left to be spontaneously absorbed, collapse at a later stage, if then desired, would be prevented by extensive adhesions. In similar circumstances with spontaneous pneumothorax it may be desirable to maintain the collapse artificially. Phthisis complicating diabetes mellitus is prone to assume a rapidly spreading caseous form, and if unilateral when discovered should be regarded as an indication for collapse.

(b) *Indications in Bilateral Disease.* In the majority of cases of pulmonary tuberculosis at the time of coming under observation the disease is not confined to one side. Although the end-results of pneumothorax are by no means so satisfactory as in the unilateral case, collapse therapy of the more affected side is not necessarily excluded as a possible means of benefit.

Throughout the course of treatment the condition of the functioning lung must be watched with even greater vigilance. Although subjected to an added strain, yet if the case be chosen with care, a lesion on this better side may improve or heal as a result of the more satisfactory general condition and reduced absorption of toxins which follow collapse of the more affected lung. An added factor in healing of the functioning lung is the hyperæmia which also occurs from diversion of the pulmonary circulation.

The collapse must be induced gradually, and often kept partial with low pressures, avoiding any displacement of the mediastinum which would cause an added strain on the better side and a flare-up of disease. The selection of case must be a matter for individual

judgment. The writer's view, based on cases referred from a variety of sources for continuation of ambulatory treatment, is as already expressed, that its capacities are being strained by a too generous view of its indications and possibilities.

An apical lesion on the sounder side is less of a contra-indication than is a basal with its greater expansion. Infiltration of the left base is particularly dangerous and apt to flare, in view of the pressure and constant movement conducted from the heart. The type of bilateral disease most suited for pneumothorax is that in which an old and fibrotic lesion of one apex without great activity is complicated by an acute spreading exudative flare of disease on the contra-lateral side. This latter lung should then be cautiously collapsed, avoiding high pressures. The radiological appearance furnishes a further guide. Soft fluffy shadows with ill-defined edges suggest activity of disease. The older and less active the lesion the more linear, dense and sharply defined do the shadows become. As a working guide it may be said that if pneumothorax is contemplated on one side, there should not be greater involvement in disease than one-third of the opposite (sounder) lung. Prolonged general hygienic treatment will all the more be needed, and in some cases supplementary measures such as gold administration.

In a few cases, bilateral collapse may be employed ; its more usual, and certainly more often successful, application is by allowing the originally collapsed lung to expand, completely or in part, followed by induction of pneumothorax on the opposite, more recently affected, side. More rarely, collapse may be maintained on both sides simultaneously, a procedure calling for considerable dexterity. In either case the results of pneumothorax treatment in bilateral disease bear no comparison with those in unilateral disease.

Contra-indications. The most obvious contra-indication to artificial pneumothorax is the frankly bilateral case, whether acute or chronic. The opinion already expressed may be repeated, that pneumothorax is often expected to cure cases which are really of this group.

The fact that a unilateral case is early is in itself no contra-indication to attempting pneumothorax if on other grounds already detailed it appears suitable. The time needed to restore to health can by these means frequently be shortened. Nothing under a year's sanatorium treatment is of any lasting benefit, and only too frequently under the present scheme of institutional treatment initial improvement is promptly followed by relapse on returning to inferior home conditions.

The chance then of inducing collapse has been lost owing to extensive adhesions. One feels that, admitting the failures of pneumothorax, more cases would become permanently arrested if every case with active spreading disease of one lung and a positive sputum were collapsed without delay.

From the pulmonary aspect the main contra-indication apart from bilateral disease is the chronic fibroid type where, even if a space were found despite adhesions, the lung would in virtue of its loss of elasticity become displaced rather than collapsed. Other pulmonary contra-indications include severe emphysema and chronic bronchitis, whether primary or secondary to asthma, and fibrosis due to any other cause, where further reduction in the capillary lung-field is not tolerated. From the general standpoint, any myocardial weakness or lack of compensation is an absolute bar to collapse, since the added circulatory load and possible displacement hamper still further the already burdened heart and may produce gross failure. Similarly above the age of 45 to 50 years pneumothorax is seldom well borne.

INDICATIONS IN NON-TUBERCULOUS DISEASE

Pneumothorax is usefully employed as a means to abolish the pain of acute pleurisy when this is excruciating and unrelieved by simpler measures. Relief is usually dramatic from the introduction of a moderate amount of air, e.g. from 200 to 400 cc., enough to ensure separation of the pleural layers. Recently induction of pneumothorax has been advocated in the treatment of lobar pneumonia (Taylor [1], Coghlan [2]). Its trial is still in the experimental stage, and only a small proportion of cases will be suitable. Its employment should be restricted to cases seen early, within three days of onset, where consolidation is confined to one side, there is no complicating factor of previous cardio-vascular disease and, especially, where serum treatment is unsuitable. The rationale is, as in tubercle, an aim at resting the affected lung and thereby reducing the circulation of toxins by collapse of the pulmonary vessels and lymphatics. The introduction of from 300-400 cc. of air on the affected side, not necessarily a painful process, is followed in favourable cases by marked falls of temperature, pulse and respiratory rates as an artificial crisis, in others by a more gradual lysis, with coincident improvement in the general condition. The relief of pain alone makes for progress, but in the few cases personally observed this has not appeared to be the sole factor. A temporary increase of fever following the introduction has been described prior

to the improvement, although in the writer's limited experience this is not invariable. Absorption of air from the hyperæmic pleura is rapid, and two or three further injections of similar or larger amount may be needed at 12- to 24-hour intervals should fever and general symptoms recur. Contrary to what might be expected the likelihood of empyema does not appear to be increased by this treatment. Many more cases need to be reported before any final conclusion can be formed of its value, but it appears promising and the results so far justify an extended trial.

In the treatment of bronchiectasis pneumothorax, when it can be obtained, is of definite value in some cases of unilateral basal affection, where by keeping the lung collapsed over a long period the cough, offensive sputum and general intoxication are greatly reduced. Recurrent hæmoptysis may similarly be prevented. The results of pneumothorax are, however, often disappointing, for by blocking the drainage of cavities the patient's condition may be made worse. Recent work has shown the striking success, in carefully selected cases, of lobectomy, but the simpler treatment should always be tried first. It has the drawback that the collapse, to be effective, has to be maintained often over many years, since symptoms usually return when re-expansion is allowed. If unsuccessful, however, pneumothorax should not be so long maintained that, after a subsequent lobectomy, the upper lobe is inhibited from full expansion to close the resulting cavity.

In lung abscess, though advocated by some authorities, pneumothorax is contra-indicated, the danger of a septic pyo-pneumothorax being such as to make it an unjustifiable mode of treatment.

A further modern use of artificial pneumothorax is as a diagnostic measure to enable thoracoscopy to be carried out, e.g. for localisation of an intra-thoracic tumour, or as a preliminary to operative procedures such as removal of a tumour, lobectomy, or insertion of radium.

Apparatus. Simplicity of apparatus is to be desired; the cost is less while defects are readily observed and corrected. The principle adopted in the well-known Lillingston and Pearson apparatus, a modified type of which is shown in figure 1063, is one of simple siphonage (see fig. 1064), the flow of liquid from one bottle into a second graduated bottle at a lower level displacing a measured amount of air into the chest through a suitable tubing and needle. The bottles are cylindrical in shape, each of about 1200 cc. capacity with well-fitting rubber stoppers, the second bottle being marked from 0 to 1100 cc. in divisions of fifty. Inserted into the rubber tubing leading to the chest are glass filters loosely filled with sterile cotton wool, and a glass window. Safety

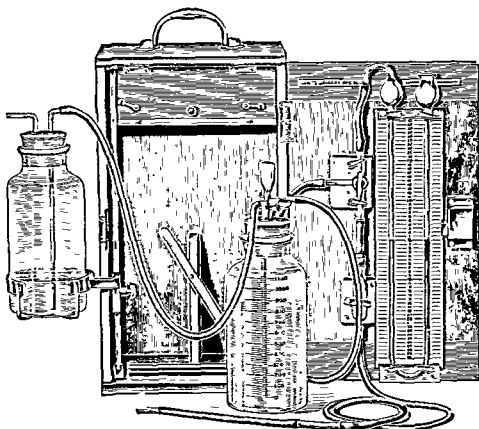


Fig. 103.—ARTIFICIAL PNEUMOTHORAX APPARATUS—MODIFIED LILLINGSTON AND PEARSON PATTERN.

is ensured by the provision of a water manometer attached to the chest-piece, so that when the needle is in the pleural cavity characteristic oscillations of the coloured fluid in its glass limbs can be seen before any air is allowed to enter the chest. An arrangement for the rapid refilling of the bottles is also fitted. Connections to the bottles and to the chest can each be closed by suitably placed taps or clips, the use of taps ensuring longer life to the rubber tubing. The fluid

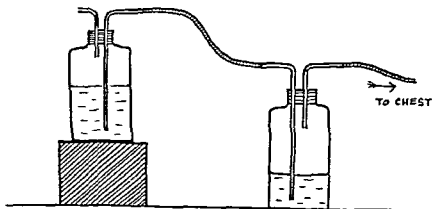


Fig. 1064.—PRINCIPLE OF SIPHONAGE.

commonly used in the bottles either a 1 in 100 solution of carbolic acid, or 1 in 1000 mercuric chloride, and may be coloured if desired. The bottles are readily sterilised with strong carbolic acid and the tubing boiled or dry sterilised.

Many other forms of apparatus have been devised of which space does not allow detailed description. Heaf's apparatus (fig. 1065) is a

simple type, lighter and more compact than the Lillingston and Pearson and avoids the need of a water container. Air is displaced by the even collapse of a bellows of 500 cc. capacity having a heavy metal cap and graduated scale. Inlet and outlet taps are fitted, with a reducing valve

and spring manometer between the bellows and the chest-tubing. Between the manometer and the needle a simple filter is placed. The flow of air can be regulated by adjusting a screw on the reducing valve.

Wingfield's apparatus (fig. 1066) works on a rather similar principle, having a brass hand-pump which expels exactly 50 cc. of air into the chest at each stroke. It is fitted with valves and a spring pressure gauge, while a pin-hole opening in the delivery-tube acts as a reducing valve and prevents air from being forced in under too high a pressure.

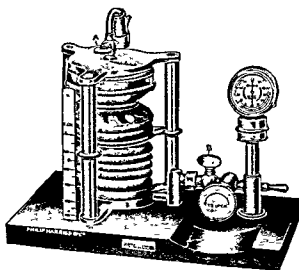


Fig. 1065.—HEAF'S PNEUMOTHORAX APPARATUS.

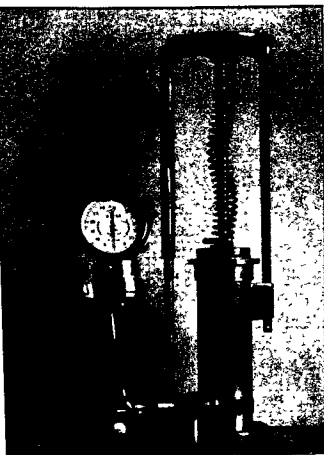


Fig. 1066.—WINGFIELD'S PNEUMOTHORAX APPARATUS.

Technique of induction and refills. It is essential that for induction and the early part of treatment, usually for the first three to four weeks, the patient should remain in bed. In some circumstances more prolonged recumbency is necessary.

No elaborate preparation or special diet is needed, but it is better not to induce the pneumothorax immediately after a meal. Preliminary injections of morphia or atropine are also unnecessary, although if the patient is apprehensive and nervous 20-30 grains of bromide may with advantage be given an hour earlier. It is very rarely that stimulants are called for, but it is wise to have available at the induction the usual restoratives such as brandy and a hypodermic syringe ready charged with 1 cc. of adrenalin solution.

A correct posture of the patient in bed is of importance. He should lie with the affected side uppermost, the ribs being well separated by pillows placed under the sound side, the head being kept low with only a single small pillow not supporting the shoulder.

The site of choice for induction is where the chest wall is comparatively thin, the ribs most widely separated, and the excursion of the lung a maximum, with less probability therefore of adhesions. Friction signifies movement beneath and a probable free space. Over signs of cavitation puncture is best avoided. The radiological appearances also are a guide in selection of site.

These considerations apply most favourably to the flank in the mid-axillary line where the first attempt at induction should normally be made, either in the 4th or the 5th intercostal space. If not successful the attempt should be repeated in the adjoining space either above or preferably lower. If again no free pleura is found, a third puncture may be made posteriorly in the 7th or 8th space immediately below and internal to the inferior angle of the scapula, avoiding the thick scapular muscles by drawing the arm well forwards and upwards. If three punctures in different places are equally unsuccessful it is unlikely that further attempts will be of value, since the lung is probably widely adherent to the chest wall and at the best an indifferent collapse of doubtful benefit will be obtained. In any case not more than three attempts should be made at any one sitting. In some patients they may be made on successive days. It is quite safe, if it is desired to pursue attempts at collapse and other sites fail, to try to obtain a swing in the first or second intercostal space, keeping strictly in the mid-clavicular line. If the pleura is adherent here also, further attempts at pneumothorax should be abandoned.

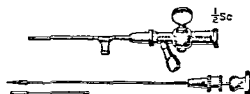
It is not possible to foretell with any exactitude in which cases

adhesions are present or whether in a given case collapse will be obtained. It is sometimes successful even when X-ray appearances suggest extensive adhesions, and similarly undue optimism is sometimes met with disappointment. It is of course essential to have a first-class skiagram of the chest before treatment is begun, and in some cases stereoscopic films are helpful, though not necessary as a routine.

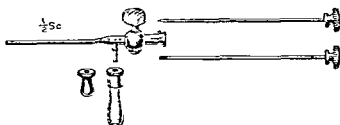
The skin of the area chosen is first prepared with ether and iodine, and the site of induction thoroughly anæsthetised with plenty of 2 per cent novocaine and adrenalin solution, paying especial attention to the parietal pleura. If the Riviere type of induction needle is used it is helpful to make a small preliminary nick into the skin with a sharp scalpel to lessen the degree of pressure needed in inserting the induction needle and render it easier of control. With the smaller bored Küss pattern of induction needle, as with all refill needles, this nick is not necessary. All needles used for chest work should, of course, be really sharp when the procedure of puncture should be completely painless. Both induction and refill needles are used dry, being either dry sterilised or flamed from spirit. Types of needles in common use are illustrated in figures 1067 (a) and (b).

The induction needle is designed to avoid injury to the lung by type puncture of the visceral pleura. The most commonly used Riviere (fig. 1067 (a)) has a sharp bayonet-pointed trocar passed through a blunt circular-ended cannula. Refill needles, on the other hand, have no need for this precaution and can have a simple sharp bevelled point. With the fluid in the two bottles level and the needle connected to the apparatus and open solely to the manometer, the needle is inserted slowly through the subcutaneous and muscular tissues, gauging their thickness according to the patient's nutrition. When at the required depth, the trocar is withdrawn and the blunt-ended cannula pushed gently but firmly through the parietal pleura, which often gives way with an audible pop and a sense of sudden ceasing of resistance. It is important at this stage that the patient should breathe regularly and avoid any restlessness or cough, and that the needle be kept perfectly still, otherwise its point readily slips out of the space found. When the end of the needle is definitely between the pleural layers, a well-marked swing of the manometer fluid occurs with inspiration and expiration and a negative pressure of several centimetres is shown on the scale. Then and then only is it safe to open the clips, or turn the taps as the case may be, and allow air to enter the pleura.

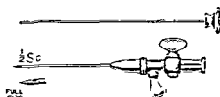
The negative pressure found varies a good deal in different cases,



Riviere Induction Needle.



Kist Induction Needle.



Chandler's Refill Needle.

Fig. 1067(a).—TYPES OF PNEUMOTHORAX NEEDLES IN COMMON USE.

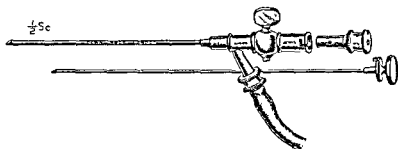
being often in the neighbourhood of an average of -10 cms. of water. The amplitude of swing also varies, of course, with the depth of breathing, but it should normally be at least 4 cms. of water to be convincing evidence of a successful insertion.

The clips are opened or the taps turned and air is allowed to be sucked in by the negative pressure of the chest until 100 cc. or so have entered. Then by raising the proximal bottle slightly about 300 to 350 cc. in all are introduced. The manometer readings and the volume of air given are recorded and the needle withdrawn. Collodion is usually unnecessary; pressure by the patient with a pad on the site of induction and avoidance of cough, aided if need be by a linctus, will prevent bleeding and surgical emphysema. A rest of half to one hour after a fill should be enforced, at least at the beginning of treatment.

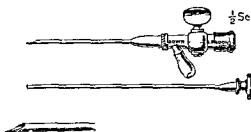
There is no fixed amount of air for induction, but it is inadvisable to give a larger volume than stated above, since undue compression of the lung in the early stage of collapse may by squeezing out tuberculin into the blood stream cause undesirable general disturbance and put excessive strain on the sound lung. Any disease of the healthier lung

is an indication for greater caution and small fills. It should be an invariable rule never to give a second fill until any general reaction from the previous one has completely subsided. If this precaution is observed, the disaster of precipitating a rapid contra-lateral spread at the onset of treatment will be avoided. Similarly it is usually undesirable at this stage to raise the pressure at a fill by more than 4 cms. of water.

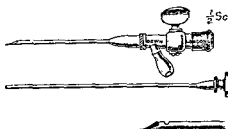
It is usually evident from the start whether a good collapse is likely to be obtained or whether only a small space has been discovered surrounded by adhesions. In the latter instance the pressure rises rapidly,



Morriston Davies' Refill Needle.



Saugman's Refill Needle.



Lillingston's modification of Saugman's Needle with closed end.



Morland Refill Needle.

Fig. 1067 (b).—TYPES OF PNEUMOTHORAX NEEDLES IN COMMON USE.

even to the positive side, with the introduction of only a small volume, e.g. 100 cc. of air, an indication that attempts at collapse are not worth proceeding with, at least at the present site of puncture. Further trial should be made elsewhere on the chest.

If no marked negative pressure is recorded nor oscillation of the manometer obtained, the needle is not in the pleural cavity. If the rule is strictly adhered to, not to admit air in these circumstances, the risk of air-embolism is completely avoided.

In a few instances the manometer records a high negative pressure as soon as the needle is introduced, but oscillations are slight or rapidly cease. The cannula end is in the pleural cavity, but is blocked by the visceral pleura. In these circumstances it is readily cleared either with a special blunt trocar or by allowing a little air to be sucked in to separate the layers by opening and immediate closure of the clip.

If the end of the needle be in the lung tissue or a bronchus, small oscillations occur with breathing of about a centimetre or two around a mean atmospheric pressure. If in error air is then introduced no rise of pressure occurs. Insertion of the needle into a blood-vessel is extremely rare, and is shown by a high steadily rising pressure and the appearance of blood in the glass window of the tubing. Similarly if a pleural effusion be entered, liquid appears in the tubing and no swing is obtained.

Choice of gas. The use of air is now universal. Nitrogen gas is absorbed slightly more slowly, but difficulties of preparation far outweigh any practical advantages. Oxygen is occasionally used by some physicians where a rapid absorption of gas is wanted, as after the replacement of a pleural effusion.

Refills. It is in the assessment of refill requirements that judgment is most needed. As regards amounts of air, spacing of fills and optimum pressures each patient is a law unto himself.

The pleura is most absorptive early in treatment. The longer a pneumothorax is maintained the more slowly is the air absorbed and the less frequently, therefore, are refills needed as time proceeds, with correspondingly smaller volumes at each fill.

If collapse of the lung is induced gradually over three to four weeks, while the patient is resting in bed, little subjective discomfort results from the altered intra-thoracic pressure—at the most some temporary shortness of breath and tightness of the chest, which the patient can be assured will pass off. The first refill is given on the day after induction,

and the intervals thereafter increased gradually, usually by a day at a time until a week is reached between refills. The object is to get the lung collapsed to the desired extent during the time the patient is in bed, and then so to maintain this level by correct control of the intervals and amounts that neither does the lung prematurely expand in concertina-like fashion between fills nor is unnecessary compression and mediastinal displacement produced.

In finding the optimum interval for a particular patient the aid of X-ray screening is essential. The duration of each exposure should be short—a few seconds suffice, search for details of lung infiltration being reserved for films. Until the collapse has become well established screening before a refill is as valuable as screening after, in that the maximum expansion between refills is seen.

The interval between refills in most cases can after the first few months be gradually lengthened to about a fortnight, and then increased slowly to three, four or more weeks towards the latter end of treatment.

The guide throughout treatment is intra-pleural pressure and not fixed amounts of air. Having found the optimum pressure for complete collapse, the object should be to restore this final pressure at each refill. Considerations of what is the optimum pressure at a particular stage of treatment will vary with other factors during the progress of the case.

When it is found that approximately the same volume of air is needed at each refill to maintain a constant final pressure it may usually be assumed that the progress of the case is satisfactory and that the collapse is being kept up to the same degree. Any sudden alteration of initial pressure or of the amount of air required calls for investigation, and usually means the appearance of fluid. The volume of air needed varies also with the degree of exercise taken, the presence or absence of adhesions, and the individual capacity of the chest.

Too great a volume should not be given at each refill. The need for more than about 600 cc. of air is an indication of undue expansion between refills and calls for a corresponding shortening of the interval. On the other hand, if the amount is less than say 200 cc., refills are probably being given needlessly often. It is safer to err on the side of too frequent rather than too large refills.

The presence of adhesions has a great influence on the volume of air needed and the pressure in the pneumothorax cavity. If they are extensive a rapid though temporary rise of pressure, e.g. up to +20 cms. or more, occurs as soon as air is introduced into a small localised space.

With more slender adhesions the rise is less rapid, and early in treatment a safe degree of stretching can be obtained by cautiously raising the final pressure. In the early stages positive pressures should be studiously avoided; adequate collapse is usually obtained simply by a lowering of the negative pressure originally present, keeping slightly on the negative side of atmospheric. High positive pressures increase the risk of pleural effusion resulting from rupture of an adhesion, and by displacement of the mediastinum give rise to tightness and discomfort in breathing, while an unnecessary additional strain is imposed on the opposite lung, with increased risk of spread. The danger is also present of tearing open a cavity with secondary infection of the pleura. Later in the treatment, when the pneumothorax cavity is contracting and obliterating, there is less objection to positive pressures in an attempt to slow down the re-expansion of the lung, or after a phrenic avulsion to increase the degree of apical collapse. It may with a shrinking space be permissible and safe to work on volume, rather than pressure control, for the mediastinum is firmly fixed and little harm results from the high pressure. In such cases the initial reading also is often remarkably low. In some circumstances the pressure is deliberately raised in an attempt to stretch an adhesion prior to thoracoscopy and cautery. The danger of rupture of an adhesion by large fills and high pressures is no small one, and a safer procedure, with better chance of stretching, is to give smaller fills at more frequent intervals.

Similarly after the outpouring of fluid or even after a dry pleurisy the rate of absorption of air by the pleura is greatly reduced. The interval may with advantage be increased and smaller amounts are needed. It is found that a higher pressure is subsequently required to maintain the collapse. In such a case oleothorax may be suitable. In the recording of pressure readings it is the mean figure only which is significant, as the width of oscillation varies both with the depth of breathing and the bore of the needle used, the finer its calibre the smaller being the swing obtained. By some the use of an oil manometer is recommended to overcome this objection, the oil by its weight giving almost a single mean reading only. It is, however, less easy to be certain of being in the pleural space, and any advantages are outweighed.

A considerable variation of pressure occurs also with alteration of posture during a refill, readings being higher when sitting up than when recumbent; for this reason the patient should adopt the same posture throughout treatment, most conveniently lying on the sound side.

The site on the chest wall where refills are given should be kept

roughly constant as long as the pleural membrane below is not found to become too tough and resistant. In that case a fresh suitable position should be discovered by screening.

During the first few months, at least, of treatment a local anæsthetic should always be given. Later as the pleura at the site of repeated puncture becomes less sensitive it may, unless the patient is unduly nervous, be safely dispensed with, provided the refill needle used is of fine bore and really sharp. With these provisos a good proportion of patients actually prefer a single prick to two, and the risk of pleural shock is not thereby increased. The skin should be held taut and, the right place being defined, the needle introduced quickly.

General effects of pneumothorax and control of the patient. The mechanical giving of fills is by no means the most important factor in treatment. Each visit calls for a careful survey of the patient for changes of any kind whether in symptoms, weight, temperature or physical signs, and for their assessment in conjunction with X-ray findings.

Frequent screening, supplemented by film examination as often as may be deemed necessary—preferably at not longer than three-monthly intervals—is essential for keeping acquainted with the progress of the case and controlling the degree of collapse. If effusion occurs, screening should be carried out before and after the refill at each attendance; for straightforward cases this is neither necessary nor desirable, as it is possible without due care to over-expose a pneumothorax patient to radiation.

Physical signs. No precise information as to the degree of collapse is afforded by ordinary physical examination. Signs regarded as pathognomonic of pneumothorax, as for example the coin sound, are much less marked than in the spontaneous variety owing to the lower intra-pleural tension. The percussion note is hyper-resonant or tympanitic, with inhibition of movement, breath sounds, voice conduction and added sounds, seldom absolute, but varying with the degree of collapse. Of greatest significance on the side of the pneumothorax are basal dullness and succussion splash, evidence of effusion. Splash on shaking, perhaps first noted by the patient, often precedes the appearance of dullness and persists after its disappearance. Encysted fluid gives rise to anomalous signs and splash is seldom elicited. In the stage of re-expansion coarse and often painless friction is heard.

Of much greater value is routine examination of the sound side,

which should never be omitted, the axillary region not being overlooked. The results of a meticulous examination at the onset of treatment should be recorded and used as a guide. Auscultatory signs are of the chief importance. Absence of added sounds does not, of course, mean absence of disease, but the fresh appearance of fine inspiratory râles is of the greatest significance, nearly always meaning a spread of active disease, and calls for immediate X-ray confirmation. Coarse râles, especially if not persistent with cough, may be only bronchitic, or evidence of fibrosis and healing. Such coarse added sounds heard immediately along the border of the vertebral column are frequently conducted from the opposite side, and if confined to this region and no abnormality is seen in a skiagram over the area concerned they may be ignored. In this respect the accentuation by pneumothorax of the normal vascular shadows throughout the uncollapsed lung must be borne in mind and not be mistaken for disease.

Febrile reactions are not desired, and in the case progressing satisfactorily do not occur. They suggest either too large a refill for the patient or active disease in the sounder side. In some patients, especially at the beginning of treatment, the pleura is unduly sensitive even to the insertion of air and a febrile response occurs, accompanied by aching pain in the chest or shoulder and perhaps effusion. The rule has already been mentioned that a second fill should be withheld until any fever following the first has completely subsided.

The presence or absence of sputum must be recorded, with periodic examination for tubercle bacilli, and final pressures, length of interval, and further duration of treatment must be constantly revised in the light of progress.

The degree of collapse to be aimed at for any particular patient is that at which his general health is best maintained. Those cases undoubtedly do best in which it is possible to obtain a complete collapse without displacing the heart and great vessels (fig. 1068). For a collapse to be functionally efficient does not, however, imply that it must of necessity be anatomically complete. Too shallow a degree, on the other hand, will fail to control cough and sputum and the general symptoms of illness. It is important, moreover, not to let the lung by oversight expand completely between refills, as within only a few days it will probably become firmly adherent and difficult or impossible to collapse again. On the other hand, excessive collapse with displacement of the mediastinum, as described later, brings in its train wasting and dyspnoea.

In any pneumothorax case the body weight tends to fall slightly

during the stage of compensation. Later, if treatment is being successful, there should be a progressive increase of weight and disappearance of all symptoms of illness.

It is wise to proceed slowly during the early stages, giving full opportunity for compensation by adequate rest in bed and then proceeding to get the patient up by gradually increasing steps. In many cases it is safe to allow a return to regular light employment after about a year's treatment, unless for special reasons contra-indicated. A return to work without fear of conveying infection is also aided by a

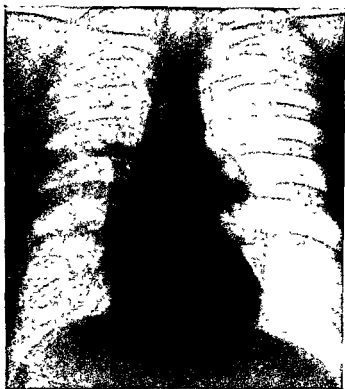


Fig. 1038.—COMPLETE COLLAPSE OF LEFT LUNG WITHOUT ADHESIONS.

disappearance of sputum or its conversion from being T.B. positive to being persistently T.B. negative. In no case in which tubercle bacilli are still present can treatment be regarded as successful. The ability to work is in itself a factor in improving mental well-being and aiding final recovery.

COMPLICATIONS

Pleurisy. Pleurisy is a constant accompaniment of pulmonary tuberculosis whenever the disease reaches the surface of the lung. The collapsing lung is not immune from a similar complication, but in virtue of the changed relationship of lung to pleura its outward effects are altered.

It is not known how common a simple fibrinous pleurisy is in the course of pneumothorax treatment, as the absence of friction between the pleural layers renders it painless and relatively symptomless. It is to be suspected when malaise and slight fever are accompanied by a rise in the initial pressure or sudden drop in the volume of air required at a fill. Not infrequently screening at the subsequent refill will reveal a trace of fluid in the costo-phrenic sinus which may be absorbed or may proceed to a definite pleural effusion.

Pleural effusion is a very common complication of pneumothorax treatment, occurring at some time and to some extent in about half the total cases. It is met with considerably more frequently among those patients in whom adhesions prevent a complete collapse of the lung, and its probable cause is the stretching and rupture of a fine adhesion at a point where tubercle bacilli can be liberated into the pleural cavity. For a like reason although no stage is exempt it is found usually early in treatment, e.g. within the first few months when the pleura is most sensitive and stretching of adhesions chiefly occurs. In a small series analysed at Victoria Park Hospital, of 164 cases in which adhesions were present, effusion was found in 78, whilst in 52 contemporary cases with no adhesions and complete collapse fluid occurred in 4 only. The precipitating factors of a pleural effusion in a given case are not clearly known, but it is a logical if unproved argument that high pressures are likely to increase their frequency of incidence. Deliberate forcing up of pressure to stretch adhesions and their actual division by thoracoscopy are not infrequently followed by fluid.

The effusion may be of any degree from a mere symptomless trickle discovered only on routine screening to complete filling of the affected side, with dyspnoea and cardiac displacement requiring replacement. The degree and acuteness or otherwise of symptoms tally in great measure with its amount—the more severe and abrupt the general disturbance the more likely is the pleural reaction to advance to a large effusion and to persist. Clinically in such a case there is malaise and fever for a few days with discomfort and aching pain in the chest, and if the effusion develops rapidly tightness and dyspnoea of proportionate degree. On examination the heart is found to be displaced with dullness and succussion splash at the base. Splash is generally best heard over moderate rather than very large effusions, and may be first evident to the patient. Screening shows the extent of the effusion with a sharp upper border remaining horizontal with alteration of posture (fig. 1069).

In by far the majority of cases the fluid is of a serous type, with the characters of a true tuberculous exudate. It is rich in lymphocytes, sterile on culture, and tubercle bacilli are not usually demonstrated except by guinea-pig inoculation.

Where the effusion persists over many weeks or months it is apt to become opalescent or turbid by admixture of structureless debris. It should be a rule to examine a syringeful of fluid periodically, say once in two to three months, in such circumstances



Fig. 1039.—PARTIAL COLLAPSE OF RIGHT LUNG, WITH APICAL ADHESIONS AND EFFUSION TO LEVEL OF FIFTH RIB ANTERIORLY.

so as to guard against its unobservedly becoming purulent. The true tuberculous empyema is, however, usually purulent from the start.

The effect of a serous effusion on the pneumothorax cavity is in the main greatly to diminish the rate of absorption of air. The intrapleural tension is increased—a marked rise in the initial pressure is constantly found, and if development has been rapid positive readings are obtained; in any case the pressure rises more abruptly than usual during a refill, less air being needed.

The degree of pulmonary collapse following effusion is often greatly improved. On this account and in view of the less frequent subsequent need for refills, the event is often not without advantage to the patient.

There is also a general thickening of the pleura in which the mediastinal covering shares, with greater fixity of its structures.

A small effusion discovered on routine screening is usually quickly absorbed in a few weeks. A larger effusion may persist for many months. In either case its absorption is apt to be accompanied by a slow process of diminution and obliteration of the pneumothorax cavity by organisation of adhesions which creep up from the level of the diaphragm (figs. 1070, 1071 and 1072), pulling at the base of the lung and causing its premature expansion and possible reactivity. To obviate such an undesired termination of the pneumothorax, in every case with fluid, frequent screening examination should be made; if below the fluid level relatively transparent air-containing lung is recognised, the effusion should be air-replaced to prevent further organisation of the pleura. If fluid is allowed to persist unremoved too long, such great thickening of the pleura may result that subsequently the lung has marked difficulty in re-expanding (fig. 1073). In other cases the effusion instead of being completely absorbed becomes reduced to a small encysted or loculated collection, most often in the axilla, surrounded by densely thickened pleura and fibrotic lung (figs. 1074 and 1075). Two or

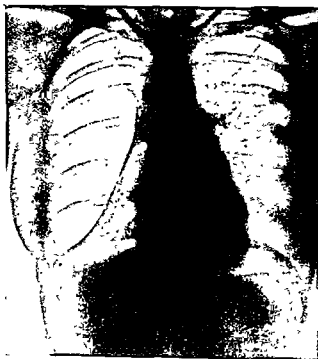


Fig 1070.—EARLY STAGE OF AN OBLITERATIVE PLEURISY. THE RIGHT LUNG IS ADHERENT TO THE DIAPHRAGM AND LOWER CHEST WALL WHERE THERE IS A TRICKLE OF FLUID. THE CONDITION OF THE LUNG AFTER RE EXPANSION IS SHOWN IN FIG. 1079.



Fig. 1071.—OBLITERATION OF PNEUMOTHORAX CAVITY ON LEFT SIDE IS IN PROGRESS FROM UPWARD SPREAD OF ORGANISATION OF ADHESIONS AFTER AN EFFUSION. THE GENERAL THICKENING OF THE PLEURA IS SEEN, TOGETHER WITH THE REMAINS OF A FLUID LEVEL. PATIENT CONTINUED WELL AND FREE FROM SYMPTOMS AFTER RE EXPANSION.

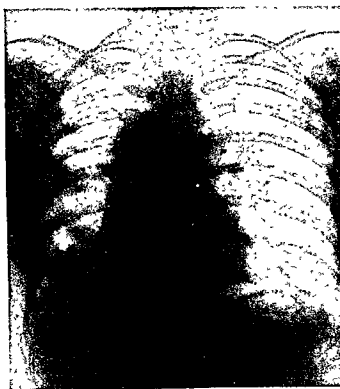


Fig. 1072.—PREMATURE EXPANSION OF RIGHT LUNG AFTER OBLITERATIVE PLEURISY. DISEASE REACTIVATED, WITH FRESH SPREAD ON LEFT SIDE ALSO.



Fig 1073.—THICKENING OF PLEURA FOLLOWING EFFUSION
(AIR REPLACED).



Fig. 1074.—RIGHT SIDED PNEUMOTHORAX SHOWING ENCYSTED
EFFUSION, DISPLACEMENT OF THE HEART BEING ABSENT.



Fig. 1075.—LEFT-SIDED PNEUMOTHORAX WITH LEFT LUNG EXPANDING BELOW A SMALL ENCYSTED COLLECTION OF FLUID IN THE AXILLARY REGION.



Fig. 1076.—LEFT SIDED PNEUMOTHORAX, SHOWING RE EXPANSION OF LUNG AT THE BASE BELOW FLUID WHICH HAS BECOME ENCYSTED, WITH MULTIPLE FLUID LEVELS.

more fluid levels may be seen and the physical signs are misleading (figs. 1076 and 1077). A fibrinous foreign body or "pleural mouse" is sometimes noted on X-ray examination (fig. 1078).

The occurrence then of a serous effusion, though calling for added care and scrutiny, does not greatly increase the difficulties of treatment, nor does it adversely affect the ultimate prognosis. Although a frequent cause of the enforced abandonment of refills, it may, nevertheless, be the starting-point of healing by dense fibrosis and scarring extending deeply from the surface into the subjacent lung (figs. 1079 and 1080), and the final condition of such patients is generally good.

A purulent effusion, on the other hand, which usually contains abundant tubercle bacilli, is always a serious complication and greatly adds to the gravity of a case.

Treatment of Pleural Effusion. If general disturbance is present, the patient should be confined to bed until it subsides. No drugs affect the progress of an effusion. The golden rule of treatment is, if at all possible, to leave the pleura severely alone. Frequent screenings should be made, say once a fortnight or oftener as indicated, to determine the level of the effusion and the degree of collapse and possible displacement of the mediastinum. It will often be found that the lung remains collapsed to the same degree for many weeks without the need for further air. Watch should be kept for any basal expansion which is sometimes rapid when absorption starts. If the fluid persists it is wise to remove a syringe-ful from time to time for examination to ensure its not becoming purulent without recognition. No refills should be given during the acute stage. The intra-pleural pressure should be taken, and if positive and dyspnoea and distress are present the withdrawal of 100-200 cc. of air from the chest will usually give relief. If the fluid level rises above the second rib and breathing is embarrassed, or if the effusion becomes purulent, it should be removed and replaced by air. The removal in one stage of too large an amount of fluid without insertion of air is apt to cause faintness, besides producing too rapid an expansion of the underlying lung with risk of renewed activity. A further possible treatment is by oleothorax, as described in detail later.

The technique of air-replacement may be briefly outlined. The best position for the patient is sitting up or semi-recumbent, with the sound side well supported by a nurse or assistant, and the patient's hand on the affected side placed on his opposite shoulder. If the effusion be large in amount some may conveniently be removed first before the introduction of air is begun. The most convenient apparatus



Fig. 1077.—LEFT-SIDED ARTIFICIAL PNEUMOTHORAX, SHOWING LOCULATED EFFUSION WITH THREE DISTINCT FLUID LEVELS FOLLOWING ADHESION OF LOWER LOBE.

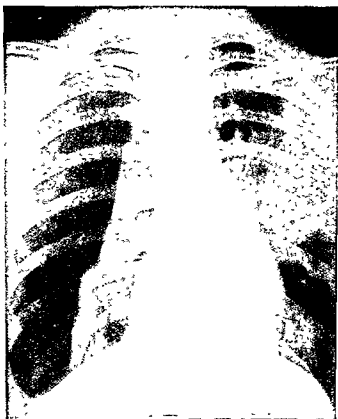


Fig. 1078.—RIGHT SIDED PNEUMOTHORAX WITH LOOSE FIBRIN BODY OR "PLEURAL MOUSE."



Fig. 1079.—RIGHT SIDED PNEUMOTHORAX AFTER RE EXPANSION FOLLOWING FLUID (SEE FIG. 1070), SHOWING CONTRACTION OF RIGHT SIDE OF CHEST WITH DENSE FIBROSIS OF RIGHT LUNG AND PLEURAL THICKENING. GENERAL CONDITION OF PATIENT EXCELLENT.

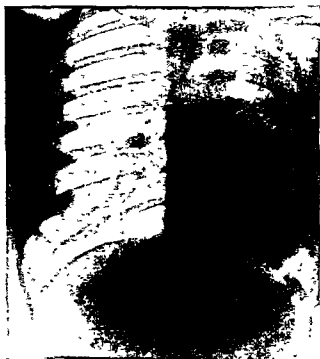


Fig. 1080.—LEFT SIDED PNEUMOTHORAX RE EXPANDED AFTER FLUID, WITH MARKED FIBROSIS OF LEFT LUNG AND DISPLACEMENT OF MEDIASTINUM TO LEFT. PATIENT FREE FROM SYMPTOMS AND CLINICALLY WELL.

for the purpose is the Chandler pattern of two-way 20 cc. syringe with ball-valve adaptor (fig. 1081), with which an even withdrawal of fluid from the chest can be most readily obtained without wide fluctuations of pressure. Alternatively, a Dieulafoy two-way syringe or Potain's or Burrell's aspirating bottle may be used (figs. 1082, 1083 and 1084). After

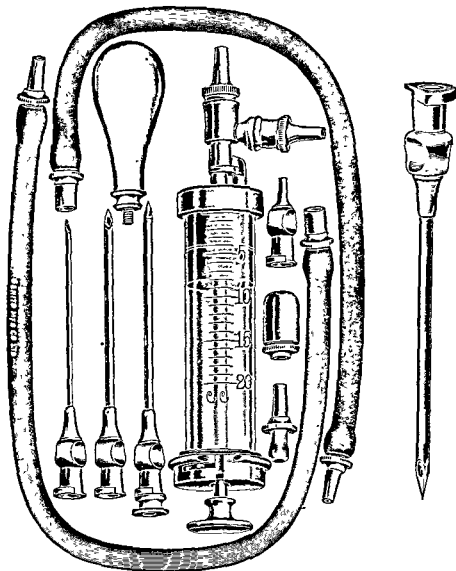


Fig. 1081.—CHANDLER PATTERN OF TWO-WAY ASPIRATING SYRINGE WITH BALL-VALVE ADAPTOR

sterilising the skin and anæsthetising the chest wall, a sample of fluid is first removed for examination with an exploring syringe, from about the 7th or 8th space posteriorly, and the needle then connected to the aspirating syringe and a further portion of the fluid removed. When a resonant note appears either beneath the clavicle or high in the axilla a pneumothorax refill needle is cautiously introduced here and air allowed to enter *pari passu* with further removal of fluid below. If the

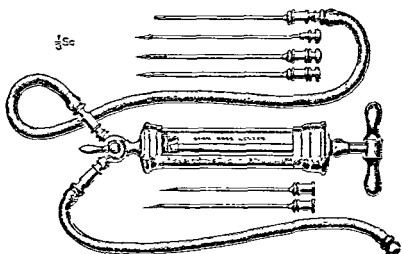


Fig. 1082.—DIEULAFOY'S TWO-WAY ASPIRING SYRINGE.

upper needle is inserted too early, no swing is obtained and the tubing becomes blocked with fluid, so that it is uncertain whether air may be introduced with safety.

It is not essential to remove every trace of fluid. When a mixture of air and froth is sucked out of the syringe removal of fluid is discontinued, and by further insertion of air as needed the intra-pleural pressure is adjusted to a final level of about atmospheric and the needles withdrawn. The patient should be screened and a film taken immediately after to record before any possible re-collection the state of collapse of the underlying lung. The whole procedure should not

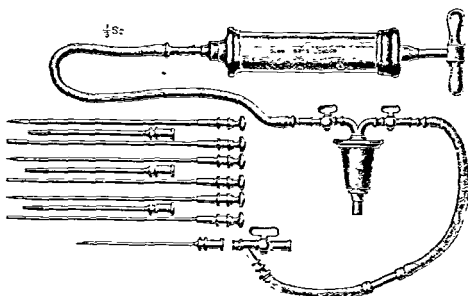


Fig. 1083.—PYLE'S ASPIRATOR.

distress the patient unduly and may be performed in an out-patient clinic. Although it can be done single-handed it is facilitated by the help of an assistant.

When the acute stage of an effusion has passed, refills may be resumed. It is invariably found that the interval may be extended and that the requirements of air are reduced.

Tuberculous Empyema.
Tuberculous empyemata fall into two groups. The simpler and more numerous are those in which secondary pyogenic infection has not occurred, although tubercle bacilli are usually present in the pus in large numbers. In many of these cases the general condition remains for a time surprisingly good, and fever may be absent. Active treatment is, however, always called for, as the longer the empyema persists the more firmly does the lung become bound down by thickened pleura with less chance of eventual re-expansion (fig. 1085). The risk of secondary infection is, moreover, always present.

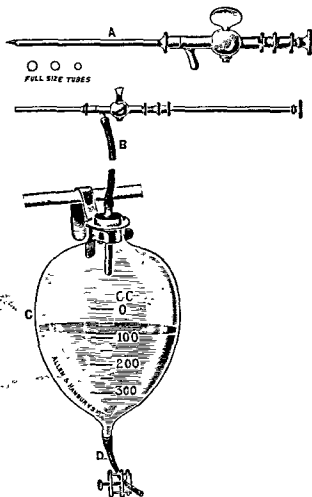


Fig. 1084.—BURRELL'S ASPIRATOR.

Any form of open drainage of a tuberculous empyema is the worst possible treatment: the wound does not heal and secondary infection at some stage is almost inevitable. An attempt should be made to aspirate the pus completely, and if large in amount to replace it by air. The risk of a needle-track with subsequent sinus-formation is minimised either by disinfecting the exploring needle before use with iodine or by injecting a little tincture of iodine along its path during withdrawal. A site for puncture too far posteriorly should be avoided in view of the possible need later for thoracoplasty. Very thick pus may be rendered more fluid and easier of removal by the injection into

the pleura on the previous day of 10 to 20 cc. of Gauvain's modifying fluid (guaiacol 2 gms., iodoform 5 gms., ether 10 gms., sterile olive oil 100 cc.).

Should the pus re-accumulate after repeated air-replacement, the pleural cavity may be gently washed out either with normal saline or with a weak non-irritating antiseptic solution, of which methylene blue (1 in 4000), acriflavine (1 in 1000), or a dilute solution of iodine (1 dr. of tincture to a pint) are equally suitable. Where the pleura is becoming



Fig. 10N.—A FIBROTIC THORACOTOMY PTO-PNEUMOTHORAX, FOLLOWING A SPONTANEOUS PNEUMOTHORAX. THE RIGHT LUNG IS BOUND DOWN AND PREVENTED FROM RE-EXPANDING IN SPITE OF SUCTION BY A DENSE COVERING OF THICKENED FIBROTIC PLEURA.

markedly thickened, half strength Dakin's solution may be used to soften and dissolve the fibrinous exudate, but its repeated use is apt to prove irritating to the pleura.

Pleural lavage is carried out in the following manner. A refill needle suitably connected to the bottles of a pneumothorax apparatus is inserted into the upper part of the pneumothorax cavity, preferably into an air space if one is present, or alternatively into the upper level of the effusion. At the lower limit pus is aspirated by a suitable two-way syringe, air being introduced from above to adjust the intra-pleural pressure. When as much pus has been removed as can be obtained, the side of the chest is gently filled up through the lower

needle with the irrigating solution, introduced either with the two-way syringe reversing the taps, or by gravity through a raised glass funnel and rubber tubing. The displaced air escapes through the pneumothorax needle. When fluid also appears at this upper level the pleural cavity is allowed to empty itself by gravity through the lower needle, while air re-enters from above. This process of alternate filling and emptying of the cavity can be repeated until the irrigating fluid comes away clear.

Lavage may be repeated at weekly intervals. The pneumothorax cavity is always more slow to close than with a serous effusion owing to the greater thickening of the pleura and consequent imprisonment of the lung. In a number of cases, however, even after months of purulent effusion complete absorption and a dry pleura can be obtained by the methods described. It is generally useless to hope for maintaining a pneumothorax when an empyema has once developed. In those cases, however, where it is particularly desired the use of gomenol oil may be of benefit in delaying the obliteration of the pneumothorax cavity.

If in spite of these measures the empyema persists and the condition of the other lung permits, surgical methods must be carefully considered before deterioration of the general condition takes place. In such a case thoracoplasty preceded by phrenic avulsion will be indicated in an attempt to obliterate the cavity.

Secondary infection of a tuberculous empyema is a grave event, and usually indicates either rupture of an adhesion or a cavity, or an intercurrent spontaneous pneumothorax. Infection from without is uncommon and due to faulty technique. Treatment is difficult and usually disappointing. An attempt should be made to clean up the cavity as far as possible and to avoid open drainage. Irrigation through two needles will sometimes clear up the secondary infection if this be only of low grade virulence. In some cases a bronchial fistula develops and re-expansion of the lung never occurs in spite of every measure. Pleural lavage is not applicable on account of the risk of flooding the lung with irrigating fluid.

In most instances some form of closed negative-pressure drainage will be required, and in some with severe septic infection rib resection cannot be avoided. In these, however, it is palliative only, with the knowledge that healing never occurs and a gradual deterioration will follow.

Oleothonax. The need for frequent refills of air has lately instigated a search for a substitute which, while remaining sterile and non-irritating to the pleura, will be absorbed more gradually. A solution of

gomenol oil of 2.5 to 5 per cent strength in either sterile olive oil or liquid paraffin has been used for the purpose under the name of oleothorax. If further antiseptic action is desired, oil of eucalyptus to a strength of 2 per cent may also be added.

The indications put forward for its use are in the main as follows :

(1) To delay the process of obliterative fibrosis of the pneumothorax cavity after a serous effusion.

(2) To replace the pus of a tuberculous empyema, especially where secondary infection is present, in an attempt to clean up and sterilise the pleural cavity by its antiseptic action. Pleural lavage is, however, usually more efficient.

(3) To produce stretching of adhesions and delay expansion of the lung.

(4) To bring about thickening and fixation of the mediastinal pleura where undue mobility is present.

As a solvent olive oil generally proves less irritating to the pleura than liquid paraffin.

Caution is needed in its use, as the pleura is sometimes sensitive to the oil and reacts by pouring out fresh fluid, with a febrile upset, shifting of the heart, and embarrassed breathing. Therefore, in the first instance only a small quantity, e.g. 5 to 10 cc. of the oil, should be injected, as a test of sensitivity. If no inflammatory reaction occurs within 48 hours it is safe to inject larger amounts. Where it is desired to replace a pleural effusion with oil, after carrying out this preliminary test, the fluid may be first aspirated, replacing with air at a higher level, and then from 100–400 cc. of warm 5 per cent gomenol oil in sterile olive oil slowly introduced with a two-way syringe through the lower needle to take its place. As the oil enters the chest, so the air is allowed to escape through the upper needle. If the pleura is sensitive, the replacement with oil may be done in several stages, in gradually increasing amounts.

The chief disadvantage of gomenol oil is that by its weight it tends to depress the diaphragm and to push the mediastinum to the opposite side, without filling the pneumothorax cavity. In many cases, therefore, its results are disappointing. Where, however, the mediastinum is already firmly fixed it is more successful. It remains sterile over a period of months and certainly does delay the process of expansion.

More recently a further advance has been made in air-substitutes. Crockett (3) has advocated as more satisfactory the use of a mixture of acriflavine and gelatine ("gelatinothorax"), which, instead of floating

as an oily layer on the surface of an effusion, will form with it a homogeneous mixture. Acriflavine is added to a 2 per cent solution of gelatin in normal saline to make a dilution of 1 in 2,500. For subsequent injections stronger solutions may be used. The replacement may, as with oleothorax, be gradual over a period of days, beginning with not more than 20 cc., or may be done in a single stage.

Pleural Shock is an extremely rare complication of pneumothorax treatment, which is fortunate as it may prove fatal and its occurrence cannot be foretold. It is due apparently to a reflex inhibition through the vagus of the medullary centres. Though occurring usually at an early stage of treatment, it may, nevertheless, appear after the pneumothorax has been maintained a year or longer. Its risk, though so small, is not, unfortunately, obviated by using a local anæsthetic. In a susceptible patient it may be produced by mere pleural puncture without injection of air, and is not therefore due to air-embolism. In the one case personally occurring in the writer's practice, in a series of over 200 patients and upwards of 10,000 refills, the patient was a girl of twenty-seven in excellent general condition whose pneumothorax had been in progress for two years, and in whom a local anæsthetic of 2 per cent novocaine and adrenalin was invariably used for each refill. No difficulty was normally encountered in her case. On the occasion in question, without warning on insertion of the refill needle, and before unfastening the clips, she complained of faintness, turned pale, and in a few seconds passed into complete unconsciousness with flaccidity, increasing blue lividity, cold skin and profuse sweating, widely dilated pupils, sighing respirations and impalpable pulse. In spite of immediate and vigorous treatment her condition gave the greatest anxiety for the following four hours, after which recovery was rapid and followed by no permanent after-effects whatever.

Treatment is to withdraw the needle at once and to treat the shock by giving 1 cc. of adrenalin 1/1000 solution subcutaneously, brandy by mouth, hot bottles and blankets, with further cardiac stimulants and artificial respiration if necessary. Happily most cases recover.

Air-embolism. The occurrence of pleural shock is a misfortune which may eventually befall any operator. Air-embolism is, however, a relic of pre-manometer days and should not occur. Provided that no air is allowed to leave the apparatus before a definite negative swing is shown, the risk is a theoretical one only. When embolism does occur it results from the introduction of air into a pulmonary vein

and is shown by sudden collapse and possib'y hemiplegia and convulsions. The treatment is as for pleural shock.

Cases have on the rarest occasions been observed where transitory, although temporarily alarming, symptoms of air-embolism have occurred without the intentional admission of air into the chest. In these instances the pneumothorax needle has inadvertently punctured the lung and entered a pulmonary vein, in which the negative venous pressure has been sufficient to suck a small amount of air from the bore of the needle and tubing without the bottle connections having been opened. A negative pressure reading is shown on the manometer but no swing. Even this rarity can, however, be guarded against by the following precautions. The pneumothorax needle should never be introduced up to the hilt. When using a needle with a terminal opening, it is usually possible to feel with the stilette before its withdrawal that the end of the needle is not touching the lung. Where novocaine is used, the sucking back of a little air into the barrel of the hypodermic syringe before it is withdrawn will demonstrate the presence of a free pleural space.

Mediastinal Displacement. If the procedure is gradual enough and positive pressures are avoided, the lung may be completely collapsed without the necessary occurrence of any displacement of the mediastinum from its normal position, even where no adhesions are present to tether the collapsing lung (see fig. 1068). In the absence of adhesions, high positive pressures cause undesirable bulging to the opposite side. In some cases, however, even where the collapse is partial and the pressures persistently negative, there is undue mobility of the mediastinum, which is not only displaced bodily to one side, but also shows a marked increase in the normal lateral swing with inspiration and expiration (figs. 1086 and 1087).

This mediastinal flutter is readily observed on X-ray screening. A bulge, on inspiration, of the anterior partition of pleura only towards the collapsed side, forming a so-called mediastinal hernia, is sometimes also present (figs. 1088 and 1089). High pressures early in treatment may also be responsible. A lung with much fibrosis also tends to be pushed across rather than collapsed by artificial pneumothorax. Although not necessarily causing symptoms this undue displacement is apt to be shown clinically in two ways—by tightness and dyspnoea after a fill, and by a progressive loss of weight, both of which are relieved on lowering the pressure.

Where no symptoms are present, and no signs are forthcoming of

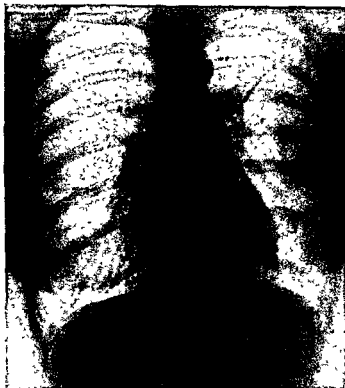


Fig. 1086.—CASE WITH LEFT-SIDED ARTIFICIAL PNEUMOTHORAX ILLUSTRATING UNDUE MOBILITY OF MEDIASTINUM. FILM TAKEN IN INSPIRATION



Fig. 1087.—SAME CASE. FILM TAKEN IN EXPIRATION. THE MEDIASTINUM HAS SWUNG RIGHT OVER TO THE OPPOSITE SIDE, COMPRESSING THE BASE OF THE SOUND LUNG.



Fig 1088.—LEFT ARTIFICIAL PNEUMOTHORAX WITH COMPLETE PULMONARY COLLAPSE AND ANTERIOR MEDIASTINAL HERNIA.



Fig 1089.—LEFT ARTIFICIAL PNEUMOTHORAX WITH ANTERIOR MEDIASTINAL HERNIA, ALTHOUGH LUNG IS INCOMPLETELY COLLAPSED AND ANCHORED BY APICAL ADHESIONS.

undue strain on the other lung, the condition does not call for treatment. If, however, the mediastinum becomes displaced in spite of low pressures with the above sequelæ, an attempt should first be made to correct it by giving smaller fills more frequently. In time the mediastinum of itself tends to become more firmly fixed. If displacement persists, oleothorax may help by producing thickening of the pleura, or phrenic avulsion may be indicated.

Selective Collapse. Since tuberculous infiltration of lung tissue is accompanied by a disorganisation of alveolar structure and consequent loss of aerating function, it follows that during the production of a pneumothorax these very areas are the earliest to show absorption of air and collapse. Conversely, where re-expansion of the lung is allowed, the healthy more elastic alveoli will again become air-containing before the adjacent areas of disease.

Such a partial or "selective" pneumothorax is advocated by some authorities, whereby collapse of the affected area of the lung only is maintained, while the healthy portion remains expanded and functioning (figs. 1090 and 1091). The chief drawback of the method is the great difficulty of maintaining the correct grade of collapse without risk of complete expansion and unintended formation of adhesions between refills, with loss of the pneumothorax. Constant screening and small frequent fills are called for. On the whole the results are less satisfactory than when a complete collapse is aimed at. For the ordinary case safety lies in maintaining a complete collapse throughout treatment, without compression of the contra-lateral lung. With bilateral disease, however, where it is essential to put no undue strain on the doubtful lung, a partial collapse only may be indicated.

The giving of large fills at infrequent intervals, whereby the whole lung, including the diseased area, is allowed to alternate between a full collapse and relative expansion, is of little benefit and to be deprecated as failing to provide adequate rest. It is worthy of note, moreover, that the lung which very readily expands between refills given at normal intervals, so that any permanent collapse is difficult to maintain, is usually not much in need of collapse at all from the point of view of activity of disease.

Contra-lateral Spread. This is one of the most disappointing complications of treatment. Its occurrence is commoner where there has been failure to attain a complete collapse of the initially diseased lung, and especially where the sputum has remained positive. It is to be

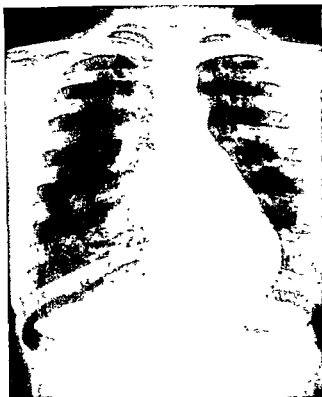


Fig 1090.—SELECTIVE COLLAISE OF RIGHT UPPER LOBE, THE HEALTHY LOWER LOBE REMAINING FUNCTIONING.



Fig 1031.—RIGHT ARTIFICIAL PNEUMOTHORAX WITH SELECTIVE COLLAPSE OF UPPER LOBE.

unpected where fresh symptoms of illness, loss of weight, or hæmoptysis arise unexplained by any change in the condition of the collapsed side. The usual direction of spread is in the form of a fan-shaped infiltration extending outwards from the region of the hilum into the mid-zone (see figs. 1072 and 1092). Physical signs may be absent or fine râles may be heard in the axilla or sub-clavicular region, while a skiagram shows a soft, fluffy, ill-defined type of mottling. Such an acute spread if promptly treated by complete rest in bed will often clear in a few weeks. It is usually an indication to discontinue refills and to allow the primarily affected lung to expand; frequently with care by giving occasional



Fig. 1032.—CASE OF RIGHT SIDED PNEUMOTHORAX WITH SELECTIVE COLLAPSE OF UPPER LOBE, SHOWING A SPREAD TO OPPOSITE MID ZONE, WITH CAVITY FORMATION.

small fills the pneumothorax cavity can be preserved, in case it is found desirable to continue the original pneumothorax in a partial form. The intravenous administration of gold salts such as crisalbin is of value, as is intramuscular injection of the more recently introduced preparation solganal-B. oleosum. Induction of a pneumothorax on the other side may be indicated.

Although seemingly opposed to orthodox principles of treatment, in certain selected cases a diseased area in the opposite apex can be compressed and controlled by deliberately raising the pressure in the pneumothorax cavity, whereby the mediastinum is displaced and acts as a splint, the pressure being directly transmitted from one side of the chest across to the other.

Bilateral Pneumothorax. The most usual application of bilateral collapse is where on account of spread of disease the second lung is collapsed after allowing re-expansion of the first. It is best, if time permits, to let the original lung come out completely before inducing collapse of its fellow.

Simultaneous collapse may be produced of both lungs (fig. 1093), in which case refills must of necessity be given alternately, each at its own correct interval, and must be kept small, with frequent X-ray control. Without due care considerable dyspnoea and loss of weight may be provoked. A few successes will be obtained with bilateral apical disease, but on the whole the final results are poor.

Adhesions. The most frequent cause of failure to obtain a complete collapse of the lung is the presence of pleural adhesions (fig. 1094). Nevertheless, it does not follow that because a collapse is not anatomically complete it is therefore not of functional value. Where, however, adhesions are so situated as to hold open diseased areas of the lung and maintain their activity, the advisability of their division has to be considered. The proportion of cases with incomplete collapse in which this is deemed desirable varies greatly in the views of different authorities in accordance with their enthusiasm and experience, even from 1 per cent to as high as 50 per cent. The writer has found that in less than 5 per cent of his total cases has such interference been considered indicated, but the tendency will with progress undoubtedly be to divide adhesions in an increasing proportion.

Adhesions which most seriously prejudice efficient collapse are commonly found at the apex extending from the posterior or lateral aspect of the lung outwards to one of the upper four ribs, or vertically upwards to the summit of the pleura. Basal adhesions seldom call for division, being more commonly multiple or forming a sheet-like membrane unsuitable for cautery. In such a case, if surgical collapse is called for, the alternative procedure of a phrenic avulsion or thoracoplasty is more applicable.

The indications for cauterisation of adhesions are matters for judgment in the individual case. The risks of division or its omission must be carefully weighed in the light of their character and accessibility and the activity of the disease. The most clearly defined indication is the presence of a cavity held open by an adhesion preventing it from collapsing, with resulting persistence of tubercle bacilli in the sputum and danger of aspiration spread. Similarly, division is to be desired, if possible, where adhesions are preventing the collapse of a

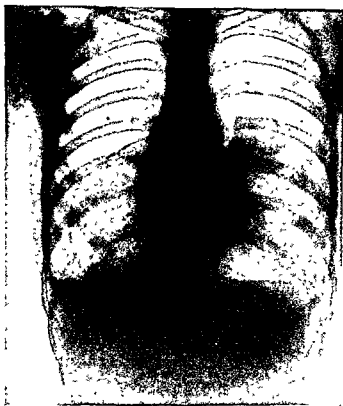


Fig. 1003.—BILATERAL SIMULTANEOUS PNEUMOTHORAX. TEMPORARY IMPROVEMENT, BUT FINAL FATAL ISSUE NOT AVERTED.



Fig. 1004.—RIGHT ARTIFICIAL PNEUMOTHORAX WITH APICAL ADHESIONS TO FIRST AND SECOND RIBS.

diseased area, apart from obvious cavitation, and cough, sputum and other symptoms of activity remain uncontrolled. Where, although the collapse is only partial, the patient is nevertheless doing well it is unnecessary and possibly harmful to interfere. It has to be remembered, however, that in the later stages of a pneumothorax the zone of lung anchored to the chest wall by an adhesion will be the earliest region to expand, an event which may usefully be delayed by division of the adhesion even in the absence of a positive sputum or demonstrable cavity.

Adhesions are brought about by the organisation and stretching of fibrinous pleural exudate. Within the first few months of treatment, as the degree of collapse improves, they may often become so elongated and attenuated as to cease to be a menace. This possibility should be borne in mind at this stage and consideration of their division reasonably delayed, although deliberate attempts at forcible stretching by high pressures are dangerous and to be deprecated.

Adhesion-cutting or synechiotomy has been rendered possible and safe by the introduction by Jacobaeus in 1913 of the thoracoscope, and the subsequent rapid developments in its technique, whereby the adhesions can be directly seen, and their suitability or otherwise for treatment decided.

For the insertion of the thoracoscope at an appropriate site on the chest wall, it is essential to obtain as accurate a preliminary localisation of the adhesions as possible. Help is afforded by stereoscopic films, but a more valuable and accurate method for determining the direction of adhesions running outwards towards the axillary region is based on rotation of the chest under X-ray screening, with films in appropriate positions, as first suggested by Chandler and described by Sparks and Wood (4). If the insertion of an adhesion on the chest wall is in front of the mid-axillary line, rotation of the patient so as to bring the shoulder of the affected side forwards causes the adhesion to appear to shorten in length; if its insertion lies behind the mid-axillary line, the apparent length will by this movement be increased.

Many modifications have been designed of Jacobaeus's original apparatus, and much valuable work has since been carried out on the subject by Maurer, Unverricht and Matson abroad, and particularly in this country by Chandler, upon whose teaching and experience the following description of technique is largely based.

Opinion has chiefly been divided upon the respective value of electro-cautery and diathermy as methods of division, and upon the opposing merits of the use of two separate instruments for inspection and for cautery respectively or, alternatively, of a combined single

puncture apparatus such as the Chandler type. Considering the latter question, for straightforward cases, given personal experience and dexterity, the advantages of a combined endoscope-cautery needing but one chest puncture are obvious, but as Chandler himself states (5), in some cases where the adhesions are multiple or unusually difficult of access the advantages of a single instrument are outweighed by the lesser certainty of approach and more restricted view obtained. In

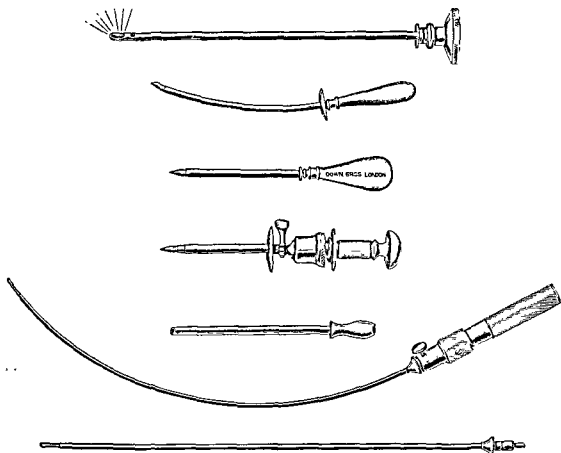


Fig. 1095.—JACOBÆUS'S PATTERN OF DOUBLE PUNCTURE THORACOSCOPIC APPARATUS, SHOWING INTRODUCERS, TELESCOPE AND CAUTERY.

such instances the use of two cannulæ, one for vision and the other for cautery, gives easier access and better illumination, and the two instruments can, if desired, be interchanged in position. Perhaps the majority of expert operators favour the latter technique as a routine method, though the factors of personal preference and experience naturally enter into their choice. In either instance in the hands of exponents such as those mentioned convincing results are being obtained.

Jacobæus's thoracoscope (fig. 1095) has two similar trocars and cannulæ, each having flap-valves to minimise the entry or efflux of air

during operation. The cautery consists of an electrically-heated platinum loop provided with a terminal hook to rest upon the adhesion during its division. The endoscope, interchangeable with the cautery, has a right-angled optical system. A bellows must be available to blow out from the pleura any smoke produced. Chandler's apparatus (6) (fig. 1096) is a remarkably neat and efficient instrument needing only one

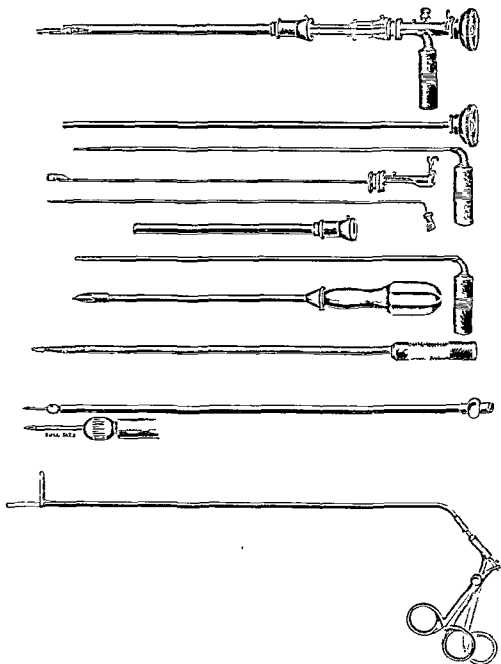


FIG. 1096.—CHANDLER'S THORACOSCOPE—COMPOSITE SINGLE-PUNCTURE APPARATUS, WITH SPECIAL ANESTHETIZING NEEDLE AND MODIFIED MACLEOD'S HOOK.

chest puncture. It is equipped with a single cannula through which there can be passed together all the necessary apparatus for the inspection and division of the adhesion, comprising a direct vision telescope, a long anæsthetising needle, a fine electro-cautery and a fine diathermy electrode serving both for coagulating and cutting. There can later be passed through the same cannula, if needed, a modified Maurer's hook, to define and steady the adhesion, and a special diathermy coagulating knob for use in case of hæmorrhage or in the presence of large vessels. A preliminary survey of the inside of the thorax can, if required, be obtained by means of an alternative right-angled-vision telescope.

Whichever pattern of apparatus is used, a refill of air is given a few days previously. If the patient is unduly nervous or the operation likely to be prolonged, a sedative such as allonal is given immediately before the thoracoscopy; morphia is neither necessary nor desirable. Using the double-cannula apparatus the thoracoscope is introduced into the chest under local anæsthesia, and after studying the interior of the pleura the suitability of the adhesions for division, and if so the most convenient site for insertion of the cautery, are decided. The first consideration is based on the shape, colour and appearance of the adhesions; those most suitable are seen as shining white cords or bands, free from obvious tubercles, with little or no conical projection from the lung or parietal aspects. A broad base and grey discoloration of the adhesion signify the likelihood of its containing lung tissue, with possibly the extension of a cavity or large blood-vessels. Which strands can be safely divided and which should be avoided experience alone can tell. If the adhesions are considered suitable the cautery is introduced, at a convenient place, through the second cannula after the trocar is withdrawn. Where the single-puncture apparatus is used, it is introduced at the site considered to give the most favourable access, judging by preliminary X-ray localisation of the adhesions. Trial beforehand on an actual skeleton of the thoracic cage is helpful in judgment of site. Varying sites on the adhesion have been advocated for cautery. Maurer's technique (7, 8), stressing the avoidance of lung tissue, is actually to peel off or enucleate the adhesion from the chest wall after coagulation, first thoroughly anæsthetising a ring of parietal pleura around its insertion with 2 per cent novocaine, through a special needle from within the pleural cavity. With long-drawn-out adhesions, however, such a precaution is not needed, and they may be severed in their course as conveniently near to the chest wall as is considered desirable. At this site, moreover, the tissue divided is less vascular and the risk of bleeding is

smaller. Lung tissue itself is an insensitive structure, but the parietal pleura is, of course, extremely sensitive, and its inadequate anæsthetisation before division at this site causes severe pain. With regard to the adhesions themselves, these also may contain nerve-endings and therefore be very sensitive, in fact the terminal quarter of an inch of their course adjoining the chest wall is invariably so, and infiltration with local anæsthetic of their structure also will be needed.

Similarly both diathermy and electro-cautery have their special indications. Diathermy of appropriate type may be used both for coagulation and for cutting. It is essential if it is employed that special apparatus be available whereby really clean sharp division can be obtained. Thorough preliminary coagulation by the diathermy current, followed by division in the centre of the coagulated area, minimises the risks of subsequent hæmorrhage and infection from sloughing of the severed ends. For the actual division either the cutting diathermy current or the electro-cautery may be used, and each has its exponents. Maurer uses the electro-cautery alone to cut through the coagulated zone. Chandler (5) advocates division of string-adhesions or slender bands by simple electro-cautery used at a dull red heat, division being safely completed in a few seconds. With stout fibrous bands, however, often containing large vessels, preliminary coagulation by diathermy is essential, carried out in stages, and alternate applications of coagulating and cutting electrodes are needed, never dividing deeper than the zone already cauterised. The procedure is slow, but cannot be hurried, and more than one session may be required if the adhesion is thick. For the cutting part of the operation either the cutting diathermy wire or the electro-cautery may be employed, and the actual procedure will vary according to which is adopted. With string and cord adhesions cut well away from the parietal pleura, the use of the electro-cautery is relatively painless and local anæsthesia may not be needed. If, however, the diathermy current is used for division it is essential to anæsthetise the parietal pleura, as otherwise a marked sense of shock and sudden muscular spasm result from its application even to the middle of an adhesion. The advantage therefore of the electro-cautery is clear. Care has to be taken, moreover, not to over-coagulate or char a string adhesion prior to its division, which then becomes exceedingly difficult owing to increased resistance.

At the end of the operation the cannulæ are removed, the site or sites of puncture closed by a suture, and a firm bandage applied to minimise surgical emphysema. A refill is given on the following day.



Fig. 1097.—ORIGINAL CONDITION WITH EXTENSIVE INFILTRATION AND CAVITATION OF RIGHT UPPER LOBE.



Fig. 1098.—CONDITION AFTER PRODUCTION OF ARTIFICIAL PNEUMOTHORAX. EFFECTIVE COLLAPSE OF THE CAVITIES IS PREVENTED BY MULTIPLE ADHESIONS TO CHEST WALL.

In the hands of experts although the operation is necessarily tedious and prolonged the immediate mortality should be negligible and serious complications rare. A pleural effusion not uncommonly follows, but is seldom serious and may improve collapse. Subcutaneous emphysema may also be temporarily embarrassing. It can be avoided or minimised by producing as little trauma as possible to the chest wall, moving the cannula as little as possible while the operation is in progress, and by always keeping the skin firmly pressed down, both during the operation, when the cannula is removed, and when the stitching-up is done. The best precaution of all is to give the patient a simple pad, with instructions to keep firm pressure on the part whenever he coughs, as well as from time to time apart from cough. In addition, cough must be prevented as far as possible by a suitable linctus, or if severe by an injection of heroin.

The chief dangers resulting from ill-advised selection of cases are severe hæmorrhage and septic infection of the pleura through opening of lung tissue, either at the time of division, or from subsequent sloughing. Occasionally after division of a major adhesion, pleural infection may occur from the spontaneous rupture of a more slender, perhaps unrecognised, strand. If there be any doubt as to its suitability for division, an adhesion should be left alone. In any case adhesions high up near the subclavian vessels or close to the mediastinum are best avoided. Where well chosen and in expert hands, the results are gratifying, and an ineffective collapse is often rendered complete, with the unquestionable advantages of lessened liability to complications and improved prognosis which such a conversion imparts. As an instance of the striking result which may be achieved, reference is made to the case illustrated in figures 1097-1100. In this example a complete collapse has been obtained of an upper lobe previously adherent and riddled with cavities, following division of the adhesions with the single-puncture apparatus by Dr. F. G. Chandler, to whom the writer is indebted for his kind permission for reproduction. A similar though simpler case is shown in figures 1101 and 1102.

Surgical Methods of Treatment. Where simple methods of collapse by artificial pneumothorax fail or are inadequate, and division of adhesions is inapplicable, increased rest to the lung, especially to its basal portion, may be afforded by resort to surgery. Evulsion of a portion of the phrenic nerve may be combined with pneumothorax and is indeed recommended by some as a routine at the termination of treatment to retain some permanent degree of collapse. It is certainly



Fig. 1099—STRETCHING OF ADHESIONS BY RAISING INTRA PLEURAL PRESSURE PRIOR TO THORACOSCOPY.



Fig. 1100—COMPLETE COLLAPSE OF RIGHT UPPER LOBE WITH CONTAINED CAVITIES FOLLOWING THORACOSCOPY AND CAUTERY OF ADHESIONS BY DR CHANDLER WITH SINGLE-PUNCTURE APPARATUS.



Fig. 1101.—CASE ILLUSTRATING DIVISION OF ADHESIONS, SHOWING
CONDITION BEFORE THORACOSCOPY. AN APICAL CAVITY IS BEING
HELD OFF BY A LATERAL ADHESION

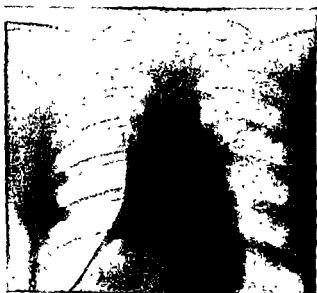


Fig. 1102.—CONDITION AFTER DIVISION OF ADHESION BY DR.
CHANDLER, SHOWING STUMP OF DIVIDED ADHESION AND COLLAPSE
OF CAVITY. ULTIMATE GOOD RECOVERY.

of value in many instances where during re-expansion there is a tendency to renewed activity or re-opening of cavities. Similarly some cases will call for apicolysis or a thoracoplasty of varying degree. The indications for such treatment or combinations of treatment are discussed in a separate section.

Duration and Termination of Treatment. There is no absolute rule as to how long collapse by artificial pneumothorax should be maintained. A great deal depends upon the degree and type of initial infiltration, and in particular upon the presence or absence at that time of cavities.

The sound healing of a tuberculous lung is necessarily a slow process. Decision must be based upon the individual case, but as a rough guide it may be said that an average total period of collapse of from two and a half to three years should be aimed at. In some the lung may be safely allowed out within a year, in others an even longer period than that stated is required. It is surprising how completely the lung is able to expand and how good its restored function may be even after three years of complete collapse (figs. 1103 and 1104). Excessive duration of a pneumothorax, however, is apt to cause an unnecessary degree of residual fibrosis and mediastinal drag, and even of resulting cardiac embarrassment.

The constant possibilities during treatment of effusion or contralateral spread have also to be borne in mind. There are two methods of allowing expansion which may be adopted—the one a sudden discontinuance of refills, watching the lung by screening during re-expansion, which usually occupies a period of three to four months. The alternative method, favoured by the writer, is to combine a gradual lengthening of interval with a progressive diminution of final pressure, e.g. by -1 cm. at a time, allowing the lung to expand more slowly over a period of about six months. There is less risk in this way of the occurrence of a pleural effusion during re-expansion, as is apt sometimes to follow the sudden abandonment of refills where the negative pressure is high. Sensations of dragging and discomfort in the chest are also less likely to be observed.

The stage of re-expansion forms the most critical period of treatment for the patient, who must remain throughout under continued observation. Any recrudescence of symptoms or X-ray evidence of re-opening of cavities will call for a further prolongation of the pneumothorax.

The most favourable time to choose for allowing re-expansion is



Fig. 1103.—RE EXPANSION OF LEFT LUNG AFTER THREE YEARS' COMPLETE COLLAPSE; ORIGINAL CAVITATION REPLACED BY LINEAR SCAR. NOW NO ABNORMAL SIGNS OR SYMPTOMS, HEALTH ROBUST.



Fig. 1104.—DENSE FIBROSIS OF RIGHT UPPER LOBE WITH MARKED TRACHEAL DEVIATION, FOLLOWING ARTIFICIAL PNEUMOTHORAX AND SUBSEQUENT RE-EXPANSION. NO SYMPTOMS OF ILLNESS, GENERAL CONDITION EXCELLENT.

during the summer months, when the risk of catarrhal infections is at a minimum.

In a considerable group of cases, however, re-expansion of the lung occurs not from choice but in spite of attempts to maintain collapse, especially when an obliterative pleurisy follows effusion. As already stated the final results in such patients are usually good. When the pneumothorax cavity becomes very small and high pressures are needed to maintain any collapse at all, little if anything is gained by attempting to pursue the pneumothorax further and the lung should be allowed to come out. In some cases again where premature expansion takes place from this cause with return of symptoms, and when the condition of the other lung permits, it may be correct to advise a thoracoplasty.

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SECTION 2

SURGERY OF THE THORAX

by
T. HOLMES SELLORS

CHAPTER I

THE SURGICAL TREATMENT OF PULMONARY TUBERCULOSIS

THE value of collapse therapy in the treatment of pulmonary tuberculosis is now firmly established, and it is only when artificial pneumothorax fails or is found to be impracticable that the application of surgery need be considered. However, in view of the fact that the collapse produced by extra-pleural operations on the thorax is permanent and irrevocable, the principles which govern the selection of purely surgical measures have to be very rigidly maintained. The chief danger of any form of collapse therapy is exacerbation of a tuberculous focus in parts of the lung or lungs, other than those in which collapse is prospected. This complication should not occur in the course of artificial pneumothorax, but if it does, the treatment can be abandoned on the appearance of any untoward signs. With extra-pleural methods, however, the collapse cannot be recovered and thus any exacerbation that occurs will run its full course.

The size of the thoracic cavity can be reduced by :

- (1) Paralysis of the diaphragm produced by section or evulsion of the phrenic nerve—phrenicectomy.
- (2) Excision of ribs—thoracoplasty—complete or partial.
- (3) Mobilisation of the pleura from the costal wall—pneumolysis—and plugging the space with living grafts or inert foreign material.

These operations may be used separately or in conjunction to procure limited or complete collapse of the lung. Complete or total

thoracoplasty is the one procedure which can produce a collapse comparable with that obtained by artificial pneumothorax. Partial thoracoplasty and pneumolysis are incomplete operations to effect a localised collapse which can be practised when the complete operations are either not necessary or are contra-indicated. Phrenicectomy is in a class by itself: its effects cannot be accurately calculated, but it can be carried out with ease and safety without the risk and discomfort attendant on the more serious measures.

It is impossible to give more than an outline of the indications for surgical treatment. Unilateral chronic phthisis is the ideal, but cases of this nature are uncommon and selection depends on the estimated ability of any tuberculous focus in the opposite lung to withstand the strain of collapse. If radiology suggests the presence of exudative lesions in the "sound" lung, surgery is more dangerous than when productive or proliferative lesions are recognised. As has been said, most of the cases which come to operation are pneumothorax failures or cases in which pneumothorax is impracticable. The chances of pneumothorax treatment producing adequate collapse in a chronic fibrosing case are considerably reduced by the presence of adhesions. If various supplementary measures—e.g. division of adhesions—are unsuccessful or impracticable the logical sequel is to employ surgical methods for collapse. *Persistence with ineffective intra-pleural collapse only deprives the patient of possible chances of cure.*

Complications of pneumothorax treatment (e.g. obliterative pleurisy and infection) often require surgical intervention if collapse treatment is to be continued. The necessity for refills further constitutes an economic disadvantage which can be overcome by substituting a thoracoplasty, but fortunately the occasions on which this is required are rare.

So far we have been mainly concerned with unilateral disease in which paravertebral thoracoplasty is a satisfactory alternative to artificial pneumothorax and must be regarded as the standard operation for complete collapse. But there are numerous instances of bilateral disease in which a combination of the various methods of partial collapse may bring about a satisfactory result. In a given case it may be that the lesions in one lung would benefit with collapse and yet disease on the opposite side contra-indicates complete collapse. Some form of partial collapse is introduced on the first mentioned side and, if control is successfully established, a partial collapse of the other lung may lead to cure. Naturally the risks taken are often considerable, but without some attempt at further treatment it may be that the

outlook of the patient is hopeless. The reason why partial collapse is not regarded as the ideal method in all cases lies in the fact that it cannot always be so contrived as to affect diseased lung only and leave healthy lung expanded. Also there is an ever-present risk of the aspiration of infected material from collapsing tissue into the healthy base.

The possibilities of surgery in the treatment of cavernous disease are not always fully recognised. Chronic cavities are sources of extreme danger in that spread of infection to other parts, bleeding, secondary infection, and persistence of tubercle bacilli in the sputum are almost inevitable. For these reasons collapse should be attempted so long as the condition of the patient is not likely to be made worse by the operation.

The diagrams on the opposite page illustrate some of the possible combinations of the various methods of collapse therapy.

THORACOPLASTY

Compared with artificial pneumothorax, thoracoplasty is a major operation of considerable severity, followed by slight though inevitable

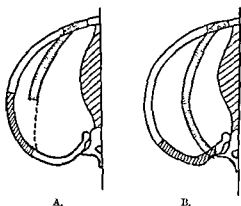


Fig. 1105—To show the importance of removing rib as far back as possible. A. shows the amount of collapse obtained by removing a length of rib (shaded) postero-laterally. The new position of the rib hinging at the costal cartilage is stippled. B. illustrates removal of the same length of rib close to the transverse processes. Reduction in cross section of the chest is much more effective.

deformity, factors that have somewhat hampered its practice in spite of gratifying results that justify its more frequent adoption.

The standard form of operation—complete or total thoracoplasty—aims at full collapse of one lung, but there is increasing preference towards partial operations which produce collapse over part of the

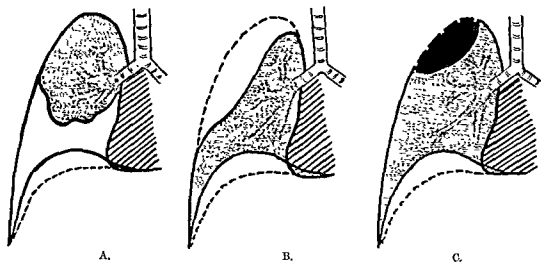
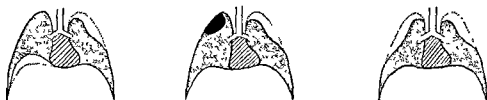


Fig. 1106.—POSSIBLE COMBINATIONS OF DIFFERENT COLLAPSE METHODS ON THE SAME SIDE. A. ARTIFICIAL PNEUMOTHORAX PLUS PHRENICECTOMY. B. PARTIAL UPPER THORACOPLASTY PLUS PHRENICECTOMY. C. APICOLYSIS WITH "PLOMBIERUNG" PLUS PHRENICECTOMY.



From left to right :

ARTIFICIAL PNEUMOTHORAX. ARTIFICIAL PNEUMOTHORAX : PHRENICECTOMY.
ARTIFICIAL PNEUMOTHORAX : PARTIAL THORACOPLASTY.
ARTIFICIAL PNEUMOTHORAX. "PLOMBIERUNG."



From left to right.

PHRENICECTOMY : PARTIAL THORACOPLASTY.
"PLOMBIERUNG" : PARTIAL THORACOPLASTY.
PARTIAL THORACOPLASTY BOTH SIDES.



From left to right :

PHRENICECTOMY : APICAL "PLOMBE."
BILATERAL PHRENICECTOMY.
BILATERAL APICAL "PLOMBE."

Fig. 1107.—POSSIBLE COMBINATIONS OF COLLAPSE METHODS ON BOTH SIDES OF THE CHEST.

lung only. Removal of ribs from the posterior part of the thorax produces diminution in the capacity of the underlying lung, and it has been shown that the greatest reduction in capacity is obtained when the resection is made as close to the spinal column as possible. The remaining anterior portions of rib hinge at the costal cartilages and swing inwards, backwards and downwards to obliterate the paravertebral gutter. The lateral loss of thoracic contour is further enhanced by dropping down of the lower and middle ribs in exaggeration of their normal "bucket-handle" expiratory fall; they lie closer to each other and even overlap like tiles or shingles. The vertical axis of the chest is principally reduced by depression of the upper ribs, particularly after division of the first. To a lesser extent the lower boundary of the thorax, the diaphragm, is raised if its costal attachments are freed. The divided ribs become fixed in their new position by bone regeneration within a few weeks and thus make the collapse permanent.

Indications. Chronic unilateral phthisis which shows a tendency towards retraction and in which artificial pneumothorax is impracticable constitutes the ideal for thoracoplasty. The major problem of disease in the opposite lung has already been discussed when the indications exceed the above ideal condition. Retraction of clavicular fossæ and interspaces associated with mediastinal displacement all suggest the tendency of the lung to favour any collapse that is offered. It must be now realised that open cavities are a permanent source of danger and that every effort should be made to obtain their collapse. Operation should not be withheld just because the patient at the moment of consideration appears to be in good health. It has been emphasised that thoracoplasty is only favourable for cases in which the proliferative aspect of the disease is predominant. A small active lesion may perhaps be overlooked, but widespread exudative disease, even though confined to one side, does not respond readily to the collapse offered.

The extent of lung involvement determines the type of thoracoplasty to be performed. With disease affecting more than the upper zone of the lung field the operation has to approach the total or complete form, but partial procedures are becoming increasingly popular for small apical lesions.

It is not possible to lay down any definite rules for the practice of thoracoplastic operations as each individual case has to be considered on its merits—more certainly here than in almost any other branch of surgery. A decision is only to be made after the most careful deliberation; thoracoplasty has no alternative sequel, its results are irrevocable

for good or bad, but it does produce a collapse of lung almost equal to that obtained by complete pneumothorax. No other single extra-pleural operation can attain the same effect.

To extend the indications for thoracoplasty to more doubtful cases is to increase the dangers, but when the hopelessness of the outlook in many cases treated conservatively is realised, it may be well worth while running risks in the hope of obtaining some benefit. With definite bilateral disease partial operations can sometimes be employed with success and bilateral upper partial thoracoplasty has been practised with good results. It is usual to try the effects of collapse on the worst side first and then if there is no ill effect to turn attention to the opposite side.

The contra-indications to thoracoplasty are divided into three groups :

(1) *General condition of the patient.*

Inability to withstand the shock of the operation from :

- (a) Extreme youth or old age. Under 20 or over 45 years thoracoplasty is rarely advisable.
- (b) Heart failure and myocarditis. On account of the toxæmia the heart may be damaged. The thin-walled veins and auricles on the right side are more liable to interference by right lung collapse than by left.

(2) *Condition of the lungs.*

- (a) Bilateral exudative disease.
- (b) Disease of the "sound" lung. Broncho-pneumonia, bronchiectasis, advanced emphysema.

(3) *Tuberculosis in other parts of the body.*

- (a) Laryngeal infection.
- (b) Enteritis and abdominal infection.
- (c) Renal infection (with the exception of a few mild cases).

The dangers of the operation fall also under several headings :

(1) *Spread of the tuberculous condition.*

- (a) Exacerbation in the "good" lung. This is the most common cause of disaster and can only be prevented by selection of suitable cases.

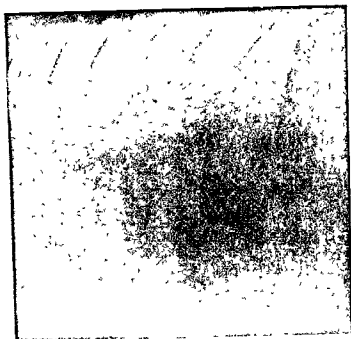
- (b) Spread of disease in the operated side. The dangers of this are reduced by the fact that collapse inhibits evolution of an active focus. In partial thoracoplasty the intermediate region between collapsed and ordinarily expanded lung and middle zone may be subjected to strain and show activation of disease.
- (c) Aspiration of infected material.

(2) *Other pulmonary complications.*

- (a) Coincident inflammation, e.g. bronchitis, influenza, massive collapse or broncho-pneumonia. The mortality of operation is less in dry summer months than in winter.
- (b) Aspiration pneumonia. An important complication which has a definite bearing on the technique of the operation. Extrusion of infected material from collapsing cavities into the main air tubes may be followed by an inspiratory effort which drags the matter into the basal bronchi. If the cough reflex is still present and is effective few ill results will occur, but during and after the operation anaesthetics and sedatives may diminish the reflex with consequent retention of inimical secretions. The size of the cavities and the amount of sputum that they may expel is an important factor.

(3) *Non-pulmonary complications.*

- (a) Shock. Excision of long pieces of rib is associated with a considerable degree of shock. This is most noticeable with extensive operations in one stage and may induce an element of danger.
- (b) Heart failure. The relatively weak walls of the right heart sustain collapse less satisfactorily than the left.
- (c) Mediastinal mobility. Before the divided rib margins have been fixed the operated side behaves in a manner similar to a lung in open pneumothorax. Paradoxical movement, mediastinal flutter and so on may occur, but usually the mediastinum is rigid as a result of prolonged pulmonary disease. Fixation of divided ribs with strapping and bandages will overcome the worst of the effects until fixation of ribs occurs by bony regeneration.



B.



A.

Fig. 1108.—TOTAL PARAVERTEBRAL THORACOCOLLASTY FOR PULMONARY TUBERCULOSIS.

B. THORACOCOLLASTY, RIBS 1 TO 10, IN TWO STAGES. THE DIMINUTION OF THE HERNI-THORAX IS MARKED. THE INCREASED SHADOW ON THE SIDE OF OPERATION IS DUE TO THE GREATER DENSITY OF HYDRA AND COLLAPSED LUNG.

A. CHRONIC CAVERNOUS DISEASE OF THE RIGHT LUNG. A LARGE APICAL CAVITY CAN BE SEEN, THE MEDIASTINUM IS DISPLACED AND THE RIBS ARE RETRACTED TOWARDS THE LOWER PART OF THE CHEST WHERE LUNG MARKINGS ARE OBTUSCURED BY PLEURAL THICKENING.

The forms which Thoracoplasty may take are :

- (1) Total Paravertebral—ribs 1 to 10 or 11.
 - (i) Single stage.
 - (ii) Two or more stages.
- (2) Partial Thoracoplasty.
 - (i) Sub-total paravertebral—ribs 1 to 8.
 - (ii) Upper lobe, all ribs 1 and 2 graded off to ribs 4, 5, or 6.
 - (iii) Apical "Spitzenplastik"—whole of rib 1 and possibly 2.
 - (iv) "Cupola-plasty"—extra-pleural pneumolysis of the whole apex followed by whole of ribs 1 and 2, and parts of 3 and/or 4.
- (3) Supplementary Thoracoplasty.
 - (i) Anterior—costal cartilages and anterior part of ribs.
 - (ii) Lateral.

Total Paravertebral Operation.

It would clearly be to the patient's advantage if a total thoracoplasty could be completed at one operation, but the accompanying

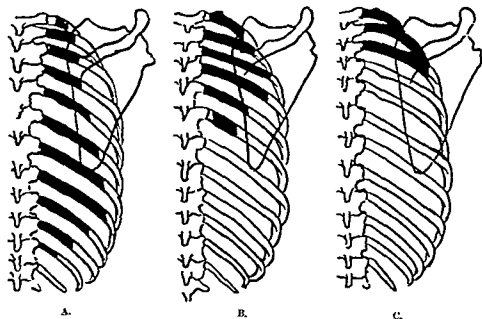


Fig 1109.—AMOUNT OF RIB REMOVED IN VARIOUS FORMS OF THORACOPLASTIC OPERATIONS. A. TOTAL PARAVERTEBRAL, INVOLVING RESECTION OF RIBS 1 TO 11 WITH THE GREATEST LENGTHS OVER 6 TO 8. B. PARTIAL UPPER GRADED THORACOPLASTY, LENGTHS OF THE UPPER SIX RIBS EXCISED WITH THE MAXIMUM ABOUT 3 AND 4, TAILING OFF AT 5 AND 6. C. APICAL OR "SPITZENPLASTIK" IN WHICH NEARLY ALL THE UPPER TWO RIBS ARE REMOVED AND OFTEN A CONSIDERABLE LENGTH OF 3

shock is severe and poorly withstood by debilitated patients. For this reason, though the psychological disadvantages are obvious, the operation is usually performed in two stages; but if the interval between the stages is prolonged over four weeks for any reason (wound infection, intercurrent infection) bony regeneration between divided ends of ribs occurs in such a way that collapse is rendered inefficient even on completion of the second stage.

A two-stage thoracoplasty is divided into an upper and lower operation, the former consisting of resection of ribs 1 to 4 or 5, and the latter of ribs 5 or 6 to 10 or 11, with an interval of two to three weeks between the stages. There is no fixed rule as to which part should be taken first. Theoretically removal of ribs from below upwards would prevent the danger of aspiration of infected material that is expressed by the collapse, but if the upper operation is done first, the most affected part of lung is collapsed early, and should untoward occurrence prevent further operation the partial collapse obtained may just suffice, and would certainly be superior to a lower collapse if further surgery is precluded.

Technique. Careful attention must be paid to the general pre-operative treatment as for any major operation. The skin of the back requires special preparation on account of the liability of a large wound to infection from acne-form eruptions. Just before operation coughing is encouraged to empty any cavities that may be present, and a preliminary injection of some sedative, e.g. omnopon and hyoscine, is given.

Anæsthesia is a difficult problem as there are objections to almost every agent. Local anæsthesia is effective, but the inevitable traction and pulling during periosteal stripping is usually resented. Gas and oxygen is satisfactory up to a point, but bleeding is more profuse than with other methods and respirations tend to become laboured. Ether has the reputation of being inimical to pulmonary lesions, though it has often been safely employed. Basal narcotics, as avertin and nembutal, supplemented by light general anæsthesia, have the disadvantage of being uncertain in their action on the cough reflex, which may be abolished for an undesirably long period. On the whole, chloroform in spite of its reputation for toxicity is as satisfactory and safe an anæsthetic as any.

The patient lies on the "sound" side with a pillow high under the axilla. When the daily volume of sputum is appreciable it is advisable to raise the head and shoulders considerably (not an easy matter with

the usual type of operating table), with a large sand-bag or sling under the buttocks to prevent slipping down. The arm on the affected side can be held by an assistant so that the scapula can be pulled forward if required.

The incision extends from the base of the neck parallel to the spine midway between the mid-line and the vertebral border of the scapula. At the lowest limit of prospected rib resection the incision is curved

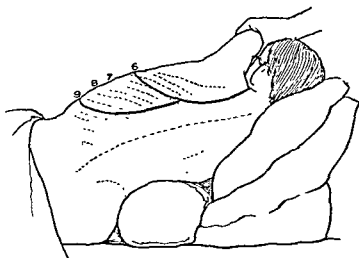
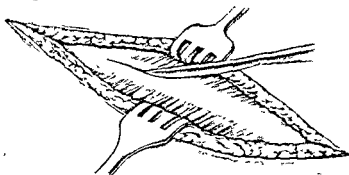


Fig 1110.—POSITION OF PATIENT AND INCISIONS IN THORACOPLASTY. THE PATIENT IS HELD IN PLACE ON THE SIDE WITH SAND BAGS. BY PULLING THE UPPER ARM WELL FORWARD THE SCAPULA IS ADVANCED SO AS TO LEAVE AS MUCH OF THE POSTERIOR PART OF THE UPPER RIBS EXPOSED AS POSSIBLE.

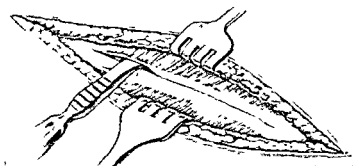
forward along the line of the rib for several inches. Deliberate division of all muscles in the line of incision is performed and this involves the lower trapezius fibres and latissimus dorsi. The rhomboids are severed, also the serratus posticus inferior, until the rib surfaces and the mass of the erector spinæ are visible. Bleeding from several medium-sized vessels requires ligature, but oozing from cut muscle and skin edges is easily arrested with pressure from hot swabs.

Division of loose cellular tissue readily exposes the rib surfaces and in the upper part the scapula is freed and raised off the chest with a hooked retractor. At this stage the intercostal nerves corresponding to the ribs about to be excised are injected with 3 to 5 cc. of alcohol or 1 per cent novocaine to reduce shock and after-pain. Ribs are then stripped of their periosteum and divided as explained in the accompanying diagrams. This is comparatively easy anterior to the rib angles, but posteriorly the aponeurotic attachments of spinal muscles are more difficult to separate. Care has to be taken in clearing the upper and lower borders of rib so that the deep stripping can be

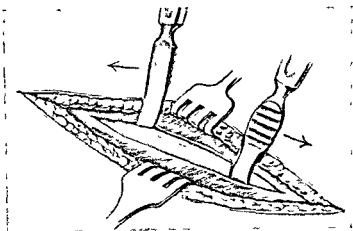
made without tearing the adherent parietal pleura. In elderly patients the periosteum tends to be more friable and difficult to free from bone. After division of rib there is a certain amount of bleeding from the periosteal bed, but this soon stops unless a perforating or main intercostal vessel has been injured.



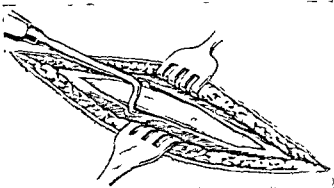
A. INCISION OF PERIOSTEUM.



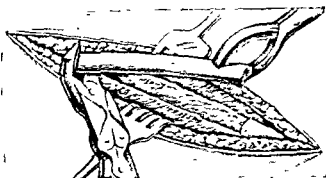
B. CLEARING PERIOSTEUM FROM SUPERFICIAL ASPECT OF RIB WITH A FARABEUF TYPE RASPATORY.



C. FREEING THE UPPER AND LOWER BORDERS OF RIB.



D. ENCIRCLING RIB WITH DOYEN RASPATORY AND THUS SEPARATING RIB FROM DEEP PERIOSTEUM. AT THIS STAGE IT IS POSSIBLE TO EFFECT EXTENSIVE RIB STRIPPING BY MOVING THE RASPATORY VIGOROUSLY BACKWARDS AND FORWARDS SO LONG AS THE INSTRUMENT IS HELD CLOSE AGAINST THE DEEP SURFACE OF BONE.



E. ONE END OF RIB HAS BEEN DIVIDED AND IS HELD UP IN BONE FORCEPS WHILE THE OTHER END IS BEING CUT WITH RIB SHEARS.

Fig. 1111 (b).—RESECTION OF RIB.

(From Sellors' *Surgery of the Thorax*, Constable, 1933.)

Regarding the amount of rib removed only a short length of rib 11 need be taken if that rib is touched at all. Ascending, increasing lengths of ribs are removed until 6 to 8 inches are resected about the level of the 8th rib. From this point there is a reduction until at the 2nd or 3rd rib only 3 or 4 inches are excised. Resection of the 2nd rib involves division of the scalenus posticus muscle, and possibly a digitation of serratus magnus.

Exposure and resection of part of the 1st rib is the most difficult part of the operation. Instead of a surface this rib presents a narrow superficial border which is cleared until the superior and inferior surfaces can be identified. Using a swab to cover a Farabœuf raspatorium, the periosteum and attached muscles (sclenus medius) can be pushed away from the bone until the rib is free except for the deep border

(Romanis). A special raspatory clears the deep aspect for a short length and a wedge-shaped piece of bone can be removed having a superficial base of $1\frac{1}{2}$ – $2\frac{1}{2}$ inches. The use of sharp instruments on the superior surface of the rib is unwise on account of the proximity of the brachial plexus and subclavian vessels. Posteriorly the proximity of the 1st dorsal nerve should be remembered.

It has been emphasised that rib must be removed as close to the transverse processes as possible, and if a projecting stump is left powerful punch forceps are used to remedy the defect.

When all the ribs have been divided it will be seen that the periosteal beds incline more vertically than before and show a wrinkled appearance due to their reduction in length. A drain is placed in the wound and the muscles are sutured carefully in layers before completing the skin closure.

Over the dressing several lengths of elastic strapping are placed and the whole enclosed in a firm binder. The arm is placed in a sling. On recovering consciousness the patient should be encouraged to cough as much as possible in order to empty his lungs of retained secretions before allowing any sedatives. The side of operation should be supported during any coughing efforts. The amount of post-operative pain is variable though it usually warrants the use of sedatives over the first few days. The drainage-tube is removed on the third to fourth day, and arm movements are instituted gradually at the end of a week or ten days.

Collapse is not usually complete immediately after the operation, and during convalescence should be assisted by the application of weights to the side of operation while the patient lies on the "sound" side.

Considering the extent of the operation the resultant deformity is very slight. Some degree of scoliosis with the convexity towards the side of the operation may occur, while the shoulder drops a little, and the clavicular fossæ are exaggerated. The scapula is, however, less noticeable on the side of operation as it falls in on the ribs, but occasionally catching of the vertebral border on a projecting central rib-end has been known to give rise to trouble.

Apart from the risk of injury to structures in the neighbourhood of the first rib there are few operative complications. The pleura may be damaged during the stripping of the deep surface of ribs, but if infected tissue is not penetrated this accident can be ignored. Infection of the extensive wound is a severe complication in an already debilitated patient.

Modifications of the standard operation include removal of greater lengths of rib under cover of the scapula which fills in the deficiency (Brauer). Excision of transverse processes is sometimes practised to enhance the posterior collapse (Maurer).

A small proportion of thoracoplasties fail to produce the desired collapse on account of exceptional rigidity or disposition of apical cavities. Supplementary thoracoplasty with excision of rib anteriorly or laterally may remedy the defect, but extra-pleural pneumolysis with wax "filling" is probably more satisfactory.

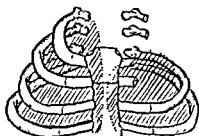


Fig. 1112.—APICAL COLLAPSE OBTAINED BY REMOVAL OF THE UPPER TWO RIBS. SHADED AREA DEPICTS LUNG OUTLINE NORMAL ON ONE SIDE AND DEPRESSED ON THE OTHER.

Partial thoracoplasty is performed along the lines of the complete operation, and the extent of rib removal is planned to conform with the requirements of the individual case. The aim is to remove as much of the upper ribs as possible and to grade off the resection so that diseased lung is collapsed and healthy tissue not affected. This type of operation is practically confined to the upper parts of the lung, and the incision has to be made long enough to allow the scapula to be lifted well off the chest wall. With careful dissection more of the upper two ribs can be removed than is commonly thought.

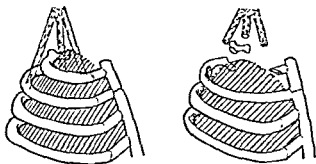


Fig. 1113.—EFFECT OF SCALENECTOMY AND REMOVAL OF FIRST RIB. SIDE VIEW OF THORAX WITH ATTACHMENT OF SCALENE MUSCLES ON LEFT. DEPRESSION OF LUNG APEX AFTER DIVISION OF MUSCLES AND EXCISION OF FIRST RIB.

The mechanism of collapse following paravertebral exposure has been considered, but there is another method of producing apical retraction by freeing the pleural dome and allowing it to sink to a lower level. This involves a most complete resection of the 1st and possibly 2nd rib with extra-pleural pneumolysis and at the same time the scalene muscles will be divided. Many approaches to the first rib have been considered with a view to performing this "Spitzenplastik." Paravertebral incisions give free access to the posterior and lateral parts of the rib with safety, but lateral and anterior incisions carry with them the risk of damage to the brachial plexus and particularly the nerve of Bell. The possibility of injury to the subclavian artery and vein has to be remembered. With anterior incisions evulsion of the phrenic nerve as it lies on the anterior scalene muscle is often practised as a supplementary measure. *Scalenectomy* has been practised as a set operation, but during any of the purely apical or dome thoracoplasty operations the division of these muscles is a matter of course.

INTERCOSTAL NEURECTOMY

Section of the intercostal nerves adds immobility to the thorax, and if combined with phrenicectomy may produce good results where other collapse operations are precluded.

Division of the 1st thoracic root is, of course, contra-indicated, but division of the 2nd to 10th or 11th intercostal nerves at the angles of the ribs leads to motor and sensory paralysis of that side of the chest and part of the abdomen.

Exposure of nerves has to be through a total thoracoplasty incision or through a series of incisions, so that the operation is more severe than it would appear to be at first sight.

PHRENICECTOMY

Phrenicectomy in Collapse Therapy stands in a unique position. Its safety and the small degree of interference necessary are considerable assets. The effect is, however, inconstant and the result uncertain. Some collapse can always be obtained, but it is difficult to predict which part of the lung will be most affected.

When the phrenic nerve is divided, the same half of the diaphragm is paralysed and the muscle, atonic and unable to contract, is elevated

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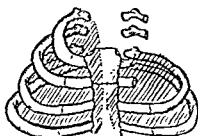


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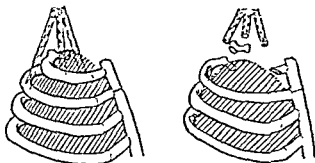


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When the phrenic nerve is divided, the same half of the diaphragm is paralysed and the muscle, atonic and unable to contract, is elevated

into the chest. The lung volume is reduced by a quarter to a sixth, and this diminution has a decided preference towards the base. In the normal lung the apical retraction is marked, but in disease the presence of a functionally rigid barrier across the chest (e.g. fibrotic lesions, thickened interlobar septum) prevents transference of the full effect of diaphragmatic ascent to the apex of the lung.

Another important factor is the character of the disease: lesions that have a tendency towards retraction clearly will benefit more than those which are rigid and resistant to spontaneous collapse.

The maximum elevation of the diaphragm is not obtained as soon as the nerve has been interrupted, though the greatest effect is seen shortly after the operation. Later the muscle atrophies and degenerates into a thin fibrous sheet which offers less and less resistance to the upward thrust of the intra-abdominal contents. The effects cannot therefore be finally judged until several months have elapsed from the time of operation.

Per se phrenicectomy is entirely satisfactory only in cases with uncomplicated basal cavities—and these are rare—but as a preliminary or supplement to other measures it is of the utmost value. Apart from an actual measure of collapse the operation has considerable advantages in the treating of certain symptoms—uncontrollable cough, vomiting in cases of left-sided phthisis, and drag of adhesions when the patient is lying on one side. Hæmoptysis can occasionally be controlled when other means are impracticable.

INDICATIONS

For Phrenicectomy alone. Middle or lower zone ulcerative lesions showing a tendency towards retraction are the most suitable. The presence of basal adhesions is also a favourable indication if these are holding up collapse. When the disease is principally seated in the upper zone phrenicectomy is only to be used when artificial pneumothorax is impracticable and thoracoplasty is regarded as too severe an operation.

For Phrenicectomy with Artificial Pneumothorax. The operation is of assistance to many cases of artificial pneumothorax, and can be viewed under two headings. When the pneumothorax is effective, certain difficulties and complications can be reduced by phrenicectomy, and in this category can be included undue frequency of refills, unexpected re-expansion (particularly at the base) and pain due to

irritation or pleural rigidity. On the other hand, when pneumothorax is incomplete and fails to bring about complete collapse of diseased areas, usually because of apical adhesions, phrenicectomy may just help treatment to become effective.

When termination of an artificial pneumothorax is prospected, phrenicectomy can be considered where it is desired to maintain some degree of collapse and to prevent undue stretch on lung tissue when it has re-expanded.

For Phrenicectomy with Thoracoplasty. As a preliminary to total thoracoplasty phrenicectomy is often advantageous. The "soundness" of the opposite lung is said to be tested by the smaller operation, and there is also a chance that if improvement accrues from phrenicectomy the extent of the rib resection can be reduced.

Phrenicectomy diminishes the risk of basal aspiration, a great advantage in partial thoracoplasty. In any case, in partial thoracoplasties a combination of the two operations should always be considered. The vertical retraction produced by diaphragmatic ascent makes a higher and more fixed point on which the rib resection can exert its effect.

For Phrenicectomy and Apicolysis. The collapse aimed at with apicolysis alone is generally much more localised than with a partial plastic operation; the effects of phrenicectomy are remote and the operation usually unnecessary unless, as often happens, phrenicectomy has been performed first and apicolysis employed later to complete the collapse.

For Bilateral Phrenicectomy. Paralysis of both sides of the diaphragm is by no means incompatible with life as was once thought. The performance of bilateral phrenicectomy is a feasible operation, though a combination of pneumothorax on one side and phrenic evulsion on the other is more usual. If the bilateral operation is prospected it is better to practise crushing of the nerve on the second side, and at a later date, if no untoward effects obtrude, to render the paralysis permanent by division or evulsion.

The operation of phrenicectomy is most simply performed in the lower neck before the nerve passes into the thorax. Simple division of the nerve is not always satisfactory on account of the occasional presence of accessory fibres which have a course away from the main



Fig 1114.—PHRENICECTOMY FAILING TO BRING ABOUT CLOSURE OF A CAVITY. LARGE AND THICK-WALLED CAVITY SITUATED UNDER THE CLAVICLE ON THE RIGHT SIDE. IN SPITE OF CONSIDERABLE ELEVATION OF THE DIAPHRAGM AFTER OPERATION THE CAVITY IS ONLY SLIGHTLY REDUCED IN SIZE.

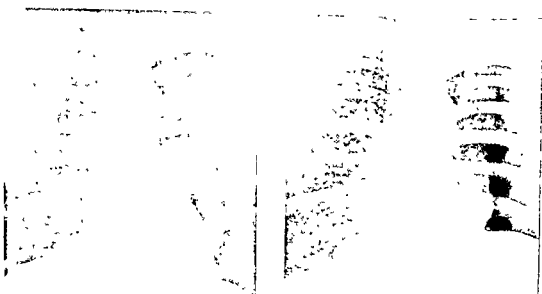


Fig. 1115.—PHRENICECTOMY AND ARTIFICIAL PNEUMOTHORAX. CASE OF LEFT PNEUMOTHORAX WITH APICAL ADHESIONS WHICH ARE PREVENTING COLLAPSE OF A LARGE CAVITY. AFTER PHRENIC EVULSION THE DIAPHRAGM IS RAISED CONSIDERABLY AND THE APICAL CAVITY IS COLLAPSED.

trunk. As a result evulsion or exaeresis is commonly practised, and though blind tearing of the nerve from its bed sounds drastic it is preferable to a radical phrenicectomy which demands free exposure of all fibres which make up the nerve. Crushing of the nerve is followed by regeneration within four to six months, and the diaphragm can be used as a temporary tampon—a procedure of great value in many cases.

Anatomy of the Phrenic Nerve. The origin and course of the phrenic is not constant. The 4th cervical nerve always supplies fibres, and with less regularity the 3rd and 5th cervical, while origin from the 1st and 2nd cervical and the 6th cervical to 1st dorsal is occasionally found. The main trunk reaches the outer border of the scalenus anticus deep to fascia covering this muscle and descends with an inward inclination to disappear into the thorax at the inner border of the muscle behind the subclavian vein. In this situation it is most accessible to surgical approach.

Accessory phrenic nerves are present in a proportion of cases, and their presence necessitates the operation of evulsion. Fibres from the 5th cervical running with the nerve to the subclavius muscle are one of the most common variations; these fibres lie over the brachial plexus and course downwards to join the main trunk close to the upper thoracic inlet. Other examples are found in filaments arising from any of the lower cervical nerves running close to the main nerve; also fibres embedded in the scalenus anticus, looping round the subclavian vein, running with the supra-scapular nerves and anastomosing with the hypoglossal and sympathetic.

Technique of Phrenic Evulsion or Exaeresis.

A preliminary injection of morphia and hyoscine or similar narcotics is advisable. The neck of the patient is slightly extended and the head turned away from the side of operation. The posterior border of the sterno-mastoid is marked and the skin and subcutaneous tissues along the line of the proposed incision are injected with novocaine ($\frac{1}{2}$ per cent to 1 per cent) and adrenalin solution. Further injection is not usually required, but can be made if deemed desirable. The incision extends for $1\frac{1}{2}$ to 2 inches backwards from the posterior border of the sterno-mastoid parallel to and about a finger's breadth above the clavicle. It is deepened through the platysma when a superficial cervical nerve may be encountered and possibly sacrificed. The external jugular vein may also be seen and retracted. The posterior border of the sterno-mastoid

is identified and deeper and externally the belly of the omo-hyoid is retracted. A mass of fat and lymph glands lies in the base of the incision below the deep cervical fascia which is incised. The opening thus made is extended and the edges held well apart with deep narrow retractors. The belly of the scalenus anticus is identified by palpation; blunt dissection downwards and inwards brings its fibres into view. As the muscle is cleared the nerve appears towards its medial aspect as a thin white cord about 1 mm. in diameter running downwards and

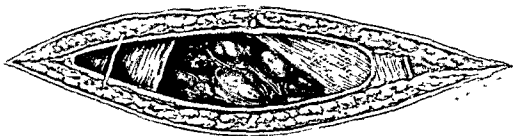


Fig 1116—INCISIONS FOR EXPOSURE OF THE PHRENIC NERVE.

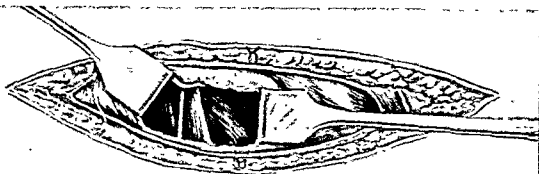
slightly towards the mid-line. Its position in relation to the muscle belly is subject to variation, and it is not always well defined until the fascia which covers it is incised.

If a low incision has been made, the transverse scapular and supra-scapular vessels may be seen coursing superficial to the nerve, and somewhat higher the ascending cervical vessels may loop over the nerve. If approach is made too far out, the brachial plexus will be exposed; if too close to the mid-line the internal jugular vein, filling and collapsing with respiration, encroaches on the exposure. Not infrequently the phrenic nerve is displaced before being recognised and carried out of the field of vision by a retractor.

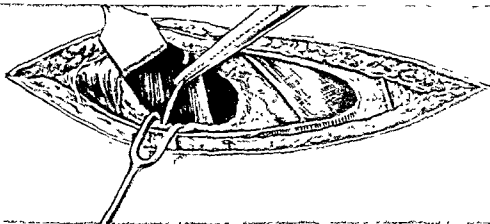
When the nerve has been identified it is freed and raised on a hook before crushing. At this point a sudden contraction of the diaphragm



A.



B.



C.

A. INCISION THROUGH SKIN AND PLATYSMA EXPOSING ON THE LEFT THE POSTERIOR BORDER OF THE STERNO-MASTOID MUSCLE. MORE Laterally (i.e. TO THE RIGHT IN THE ILLUSTRATION) A MASS OF FATTY TISSUE AND GLANDS THE OMO-HYOID WHOSE OUTLINE IS APPARENT LIES STILL MORE Laterally AT A DEEPER LEVEL THAN THE STERNO-MASTOID. THREE CUTANEOUS NERVES AND VESSELS ARE SHOWN, ONE HAVING BEEN DIVIDED.

B. WORKING THROUGH THE FATTY PAD BY BLUNT DISSECTION AND USING SMALL RETRACTORS THE SCALENUS ANTICUS MUSCLE IS EXPOSED. THE MUSCLE IS SEEN IN THE DEPTHS OF THE WOUND WITH THE PHRENIC NERVE CROSSING ACROSS IT BEVEATH A FASCIAL COVERING. BEHIND AND LATERAL TO THE SCALENUS THE BRACHIAL PLEXUS IS JUST APPARENT. AT THE UPPER LIMIT OF THE SCALENUS A VESSEL—TRANSVERSE CERVICAL—is VISIBLE AT OPERATION THE DEPTH OF ALL STRUCTURES IS GREATER THAN CAN BE DEPICTED.

C. THE PHRENIC NERVE HAS BEEN DIVIDED AND ITS DISTAL END IS GRASPED IN A PAIR OF FORCEPS. A DOUBLE HOOK RETRACTING AT THE LOWER PART OF THE WOUND WHERE THE NERVE DISAPPEARS INTO THE CHEST ASSISTS DISSECTION.

Fig. 1117.—PHRENIC EVULSION.

in the form of a hiccough is usually noted and the patient may complain of pain in the region of the shoulder. The nerve is divided and cleared of all fascia towards the lower part of the wound, where it is straddled by a two-pronged retractor.

The process of evulsion can then be started by direct pulling on the nerve or by twisting it round forceps as illustrated in accompanying

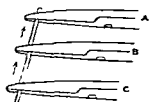


FIG 1114.—METHODS OF EVULSION OF THE PHRENIC NERVE. IN THE UPPER DIAGRAM THE NERVE IS GRASPED BY FORCEPS A AND PULLED UNTIL B CAN BE APPLIED.

TRACTION IS EXERTED ON A, BRINGING MORE OF THE NERVE INTO VIEW, WHEN C IS CLAMPED ON. EITHER A OR B ARE PULLED ON SO THAT IF THE EXPOSED NERVE BREAKS THERE WILL STILL BE FORCEPS C TO LOCATE THE DISTAL END OF THE NERVE. THE PROCESS IS REPEATED WITH SUCCEEDING LENGTHS OF THE NERVE UNTIL EVULSION IS COMPLETE.

IN THE LOWER DIAGRAM THE NERVE IS EXPOSED BY TWISTING IT SLOWLY ROUND A PAIR OF FORCEPS. THERE IS A TENDENCY FOR A LOOP OF NERVE TO SLIP OFF THE END OF THE FORCEPS AND TO AVOID THIS VARIOUS FORCEPS WITH FLANGES HAVE BEEN DESIGNED.

diagrams. The first inch or so of the nerve appears easily, but resistance is commonly encountered when 2-3 inches have been delivered. Traction should be steady and slow at this point, and the nerve either snaps short, leaving 4 to 6 inches in the forceps, or the whole length is torn from its bed. The patient may complain of deep-seated pain in the chest, but once the nerve has been torn free, relief is obtained. Bleeding from small vessels accompanying the nerve is negligible. A catgut suture to close the opening in the deep fascia and skin clips or sutures complete the operation.

Complications or accidents are rare, but nearly every structure in the neighbourhood of the operation field has been damaged at some time or other. The vagus, sympathetic, and branches of the brachial plexus have been evulsed, and great vessels damaged. Bleeding from the internal jugular can usually be arrested, but tearing of the subclavian vein by an accessory encircling loop of the phrenic has led to fatalities. Injury to the thoracic duct is common, but no ill effect seems to result. The most important difficulty encountered is failure

to find the nerve on account of slight variations from its normal position. More distant dangers lie in tearing of the mediastinal pleura in cases of old-standing disease. Empyema has resulted, and consequently if resistance to evulsion is too strong it may be advisable to cut the nerve short rather than use excessive traction. Diaphragmatic pleurisy as a result of trauma when the terminal fibres are torn is relatively common. Kinking of the œsophagus in the performance of left-sided operations has been recorded on several occasions and gives rise to an unpleasant form of dysphagia. It is partly on account of the possibility

of these complications that the more simple operation of crushing may be preferred to evulsion.

Instead of a transverse incision, a vertical one along the posterior border of the sterno-mastoid can be used, but although the exposure is freer the resulting scar is not so satisfactory.

EXTRA-PLEURAL PNEUMOLYSIS

In the absence of a free pleural space there are obvious advantages in some operation which admits of collapse without having recourse to extensive rib resection. Stripping and mobilisation of the parietal pleura from the deep surface of the ribs results in the formation of an extra-pleural space which can be maintained by the introduction of a graft or some filling material.

The operation is, however, only applicable when visceral and parietal pleural layers are adherent—a state of affairs frequently found towards the apex in chronic phthisis. If the pleural space is free pneumothorax is preferable.

It follows that the extent of the pneumolysis depends on the area of lung adherent, and that a limited operation at the apex is all that is usually contemplated. The advantage of the procedure over a partial thoracoplasty lies in the fact that more localised collapse can be obtained with a less severe operation. The principal disadvantage is the difficulty of maintaining the extra-pleural space—grafts are uncertain and the use of inert material such as paraffin wax is liable to the defects of any buried foreign body. On the other hand, a certain amount of compression can be exerted on underlying lung by the filling material, or “Plombe,” over and above the collapse obtained by freeing of the parietal pleura. This feature is a considerable asset in obtaining obliteration of rigid walled cavities which fail to respond to other collapse measures.

INDICATIONS

When used alone. A small apical cavity or a definitely localised fibrotic lesion can be submitted to extra-pleural pneumolysis if only a limited degree of collapse is desired. Here, however, the operation though less drastic is not usually as effective as a partial thoracoplasty.

Where the origin of a hæmoptysis can be accurately localised the procedure is almost preferable to all other measures so long as the pleura is adherent.

With extensive bilateral lesions pneumolysis may be tried first on the worst side in the hope that the resulting retraction will produce some improvement in the general condition, when other collapse measures can be more safely added. Though an apparently desperate procedure the benefits obtained are occasionally remarkable.

When used with Thoracoplasty. As a complement to rib resection operations the apical parietal pleura can be freed without undue difficulty after the ribs have been excised. In this way the apical collapse becomes more graded and underlying cavities are not submitted to uneven strains as the chest wall falls in. The employment of any filling material is unnecessary.

"Cupola-plasty" (Gravesen) is a specialised form of pneumolysis combined with rib resection. Following freeing of the scapula through the usual posterior incision a rib, generally the 3rd, is resected and an extensive pneumolysis performed, so that the whole apex is depressed on every aspect to the level of the resected rib. Removal of practically the whole of the first two ribs is simplified as their deeper surfaces can be reached. Further ribs below the 3rd may be removed according to the circumstances of the case. No filling material is necessary, and drainage of the dead space should be avoided so that any collection of serum will help to maintain the collapse produced at operation.

When a thoracoplasty has failed to collapse stiff walled apical cavities, pneumolysis with filling ("Plombierung") is often preferable to measures which involve further rib resection. The value of direct pressure over the patent cavity is evident.

With other measures of Collapse. When extensive apical adhesions hold up collapse during the course of pneumothorax treatment the value of pneumolysis is strictly limited as the risk of rupture into the pleural cavity at the time of operation or, later, by pressure ulceration is too great.

Phrenicectomy and "Plombierung" do not reinforce each other to any marked degree and are rarely used together. On the other hand, pneumolysis will sometimes complete a collapse which phrenicectomy has failed to attain. For example, an apical cavity may be reduced in size by phrenicectomy, but obliteration is not achieved until apicolysis has been performed.

The combination of collapse and direct pressure over an affected area may seem ideal until the disadvantages are examined. The operation is not difficult, but in tuberculosis (for be it understood that

its use in the treatment of other conditions is not here considered) it can only be employed where the cross-section of the lung is small, i.e. at the apex. The ideal filling material or "Plombe" would be a tissue graft—muscle, fat, or breast—but in practice shrinkage of the graft, its frequent failure to "take," and the limited amount available are almost insuperable difficulties. Paraffin wax is widely used, but while easy to handle is definitely a foreign body. Pressure ulceration is the most common complication; the extra-pleural space becomes infected and the wax has to be removed or discharges itself through sinuses. Sometimes the wax works its way into a bronchus and is coughed up, an accident which is foreshadowed by hæmoptysis. To avoid these mishaps the amount of the "Plombe" should be limited so that the space is only comfortably filled and not packed too tightly. Wax has a tendency to wander if its bed is not firm and secured by adhesions: on more than one occasion an apical "Plombe" has found its way to the diaphragm. Effusion round the filling is common, but if excessive can be controlled by aspiration unless infection develops.

In performance of the operation the apex can be approached by three routes:

(1) *Anterior*. Transverse incision below the clavicle over the 2nd or 3rd rib with separation of the fibres of the pectoralis major.

(2) *Lateral or Axillary*. The use of this apparently superficial and easy approach is discounted by the fact that the pleura can rarely be reached at a level higher than the 3rd or 4th rib. Wax tends to work out from this situation more readily than elsewhere.

(3) *Posterior*. A paravertebral incision allows exposure of any of the upper ribs beneath which a fair-sized "Plombe" can be placed and well covered by muscle.

Technique. The operation can be performed under local or regional anæsthesia, but as the deeper manipulations are not always well tolerated a general anæsthetic is advisable. Chloroform is particularly suitable as excessive movements of the chest are reduced to a minimum.

The skin incision should not be longer than necessary, and retraction of split fibres of underlying muscles should be carried out until the rib surface is exposed. The intercostal muscles of a selected space, usually the 2nd, are incised along the line of rib down to the level of the

endothoracic fascia beneath which the parietal pleura lies. If further exposure is required a short length of rib can be resected.

In theory the plane of cleavage should lie in the plane of the fascia superficial to the actual pleura, but in practice fusion of the various layers makes distinction impossible. A plane of separation can always be found along which dissection can be extended. The extra-pleural space now produced is then enlarged by blunt dissection under cover

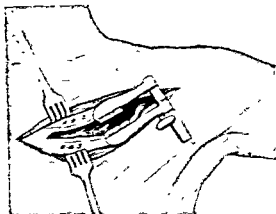


Fig. 1113.—EXTRA-PLEURAL PNEUMOTHORAX AND PARAFFIN WAX FILLING. TRANSVERSE INCISION CARRIED THROUGH THE PECTORALIS MAJOR TO EXPOSE THE SPACE. INTERCOSTAL INCISION AND SEPARATION OF ADJACENT RIBS WITH AUTOMATIC RETRACTOR. AN EXTRA-PLEURAL SPACE IS FORMED AND PACKED WITH WAX BEFORE CLOSURE.

of the ribs. The gloved finger is the most satisfactory instrument for pushing the pleura and lung away from the under-surface of the ribs. Sharp instruments are dangerous and only occasionally does any cutting tool have to be employed to divide an unusually resistant strand of tissue. If a very large cavity is required, as in true apicolysis, the dissection can be extended over the apex of the lung round the sides and back of the chest as far as the level of the hilum with safety. In this case the whole hand is inserted into the chest and the fingers continue dissection at the margins.

It sometimes happens that dissection is carried deeper than desired and lung tissue is injured. A small superficial injury into apparently healthy lung tissue can be ignored, but it is wise to touch the surface with the cautery. If the injury opens diseased tissue the risk of infection of the extra-pleural space is usually too great to consider leaving a wax filling *in situ*. It is advisable in this case to abandon the prospected operation and to try and convert it into a partial thoracoplasty or to pack the cavity with gauze in the hope that granulation tissue will maintain the collapse.

Having formed a satisfactory extra-pleural space the margins are carefully prodded with the finger to see that they are sufficiently firm to prevent wandering of the "Plombe," and pressure is applied to ensure absolute hæmostasis. Into the now dry bed wax is gently worked in pellets or small masses at a temperature at which they are malleable. Wax with a melting point of 45 to 50° C. is suitable. When the space is comfortably filled, any loose intercostal tissue that is available is sewn over the "Plombe" and the wound closed in layers without drainage. This closure should be made with extreme care to avoid any risk of infection from without.

When grafts are employed, a similar technique is adopted using the anterior route. After removing a short length of rib the graft is cut as a pedicle from muscle or breast and inserted into the prepared cavity. Fixation of the graft in permanent position is sometimes a matter of difficulty. When using muscle the tendency to pull out of the extra-pleural bed must be remembered, and if nerves are divided to overcome the latter disadvantage consequent atrophy has to be allowed for. The use of fat from other parts of the body simplifies the question of fixation, but the risk of autolysis is considerable and wax is to be preferred.

The size of the extra-pleural space that is procured by the operation varies with individual requirements. True apicolysis involves extensive freeing of the lung dome over all its surfaces. When the "Plombe" has been inserted the whole apex is well depressed and a most effective collapse obtained. Pneumolysis over smaller areas constitutes a less severe operation, but localisation must be accurate if obliteration of a specific cavity is required. The "Plombe" in this type of case varies in size between that of a golf ball and a cricket ball, and is placed directly over the cavity at the point where it is nearest to the surface.

CHAPTER II

ACUTE EMPYEMA

EMPYEMA usually results from an underlying pneumonia (whether by permeation through the visceral layer or from rupture of a minute cortical abscess is immaterial) and the infecting organism is most commonly the pneumococcus. Streptococcal empyemata occur in the course of severe forms of influenza, scarlatina and other infectious diseases, from pyæmic infarcts and by direct spread from the bursting of a pulmonary or subphrenic abscess into the pleural sac. Penetrating chest wounds are obvious sources of direct infection by pyococci. Apart from, or in addition to, the pneumococcus and streptococcus, the commonest causative agents, staphylococci, *B. Friedlanderi*, *B. coli* and anærobæ are often recognised; indeed, the mixture of bacteria often makes it difficult to decide on the predominant organism.

Consideration of the physical conditions within the thorax shows how easily the formation of a pleural exudate is encouraged. The normal lung constantly tends to retract towards the hilum, retraction being opposed and prevented by the "negative" or sub-atmospheric pressure in the potential pleural cavity. When the pleura and lung are inflamed this suction effect encourages exudation, and as the quantity of fluid increases so does the intra-pleural pressure rise and the lung retract by its own elasticity. The irritative effect of transmitted organisms adds to the product of the exudate, which may attain such proportions as to affect the mediastinum and produce pressure symptoms in the opposite lung.

As with any infective process the effect of an empyema will depend on such factors as the virulence and extent of the infection and the resistance of the patient. It must be emphasised that the secondary nature of the pleural involvement is an added strain to a patient convalescent, or actually suffering, from pulmonary inflammation.

TYPES OF ACUTE EMPYEMA

The extent of an empyema varies considerably. Total or complete empyema would imply a purulent effusion filling the whole pleural sac,

but such a condition, if the definition is strictly adhered to, is rarely found. Partial empyemata vary in content from small abscesses with a capacity of only a few cubic centimetres to collections which fill almost half the thorax. Other types owe their titles to their situation, e.g. mediastinal, apical, diaphragmatic and interlobar. The distinction between the *metapneumonic* and the *synpneumonic* types has an important bearing on treatment. In the former a definite interval elapses between the subsidence of the pneumonia and the onset of the pneumococcal pleurisy, in which thick frank pus and rapidly formed adhesions restrict the extent of the effusion. Synpneumonic empyemata are usually streptococcal and arise during the course, often at the height, of a pulmonary inflammation; an abundant effusion loaded with organisms and showing no signs of increasing viscosity for a week or more is associated with delay in the formation of adhesions.

SYMPTOMATOLOGY AND DIAGNOSIS OF ACUTE EMPYEMA

The signs and symptoms of acute empyema show considerable variations. In a case following an ordinary lobar pneumonia the crisis has usually passed several days before the temperature begins to rise again and develop a hectic swing.

The presence of fluid is detected by decreased vocal fremitus, weak distant tubular breathing, or absence of breath sounds and, above all, by a definite feeling of resistance and a dull note on percussion over the affected area. In children the vocal resonance is often increased over a dull area where bronchial or tubular breathing is fairly distinct. Indeed, in children local dullness, distant tubular breathing or absence of breath sounds, and no adventitious sounds is a combination of signs diagnostic of empyema. The pulse-rate rises in accordance with the degree of toxæmia and respirations are frequent, though not to the extent seen at the onset of the pneumonia. Embarrassment of the cardiac and respiratory organs follows displacement of the mediastinum, and is recognised by the position of the heart and inclination of the trachea in the root of the neck. The displacement of the heart and liver is greater in empyema than with the same amount of serous exudate.

Radiography is valuable in confirming the presence of fluid, particularly if a shadow of uniform density is seen lying over the lower and outer parts of the chest, masking lung markings and describing a curve whose concavity faces upwards and inwards. Localised collections are probably purulent. Variations in density of shadow are caused by the thickness of fluid and/or pleura, but the uniformity of the shadow is

the principal feature. Against this, X-rays do not reveal with any certainty thin layers of fluid, nor is any indication given as to whether the fluid is serous or purulent. The presence of pus is suggested by symptoms, and by the general appearance and temperature chart, but can only be diagnosed with absolute confidence by the results of *needle aspiration*.

This brief résumé of the diagnosis of a metapneumonic empyema is equally applicable to the synpneumonic type, except that in the latter the effusion gives evidence of its presence during the course of the pulmonary inflammation, accumulates more rapidly, and shows no sign of localisation or encystment.

Assuming that fluid has been withdrawn by the exploring syringe, it now remains to decide upon its nature. It may be the frank pus of a metapneumonic empyema: it may be the serous effusion of a non-septic pleurisy (for an acute simple pleurisy may simulate empyema very closely): or it may be the thin sero-purulent exudate of the synpneumonic type. Bacteriological examination is essential, for the fluid of a streptococcal empyema may be a little more cloudy than that of a simple pleurisy, and yet be teeming with streptococci.

From the point of view of treatment it is most important to decide whether the pus is frank and thick, implying clots and adhesions to localise the empyema, or thin and serous, when it is safe to assume that a large collection is lying free in the pleural cavity. At first sight it would seem reasonable to suppose that any collection of pus should be evacuated without delay, and such a course is correct with a localised empyema of moderate size, but a brief consideration of the physiology of the thorax exposes the error of too hasty an evacuation of large collections. It is true that a small opening in the chest wall is not necessarily incompatible with life, though the loss of ventilating surface from the consequent lung collapse and the danger of mediastinal flutter may lead to cardiac embarrassment; but the lung tissue is probably still in a state of inflammation and the reserve ventilating capacity of the chest thereby seriously reduced. Furthermore, the mobility of the mediastinum allows pressure to be transferred to the opposite hemithorax in addition to the dangers induced by its own to-and-fro movements. In these untoward factors lie the risks of an open pneumothorax in a large empyema, especially in one of the synpneumonic type, where no adhesions have as yet formed to limit the accumulation of fluid or to reduce the mobility of the mediastinum.

Needle aspiration then not only confirms the presence of fluid but tells its nature and gives definite indications as to the lines on which

treatment is to be initiated. On the one hand, there is the danger of draining the pus too early ; on the other, the risk of leaving a collection of pus too long shut up in the chest. The general principle is (a) to evacuate thick pus at once and freely ; (b) to remove thin infected fluid by repeated aspirations until the pus is thick and adhesions have formed, when a more effective form of surgical drainage can be installed.

Exploratory puncture is a simple and familiar diagnostic procedure, but several points must be borne in mind, which, though obvious, justify their mention here :

(1) The needle should be of sufficient length to reach the pleural cavity and of sufficiently wide bore to allow the passage of thick pus. It must fit the syringe accurately, and this must be tested immediately before use ; at the same time the patency of the needle can be assured. It must be new and strong to obviate any risk of snapping.

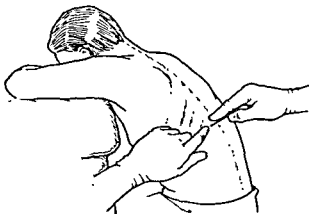


Fig. 1120—POSITION OF PATIENT DURING EXPLORATORY ASPIRATION. THE POINT OF PUNCTURE INDICATED IS SUITABLE FOR MANY CASES WITH EXTENSIVE COLLECTIONS OF PLEURAL FLUID AND IS A SATISFACTORY SITE FOR MORE PERMANENT DRAINAGE.

(2) The site of the first exploratory aspiration should be at the centre of maximum dullness. Subject to this condition, the lower and more posterior the puncture the greater the help afforded to the surgeon when he operates.

(3) After careful cleansing of the skin and instruments, the skin, chest wall and pleura are infiltrated with a dilute solution of novocaine ($\frac{1}{2}$ to 1 per cent).

(4) The needle is introduced through an interspace in the anaesthetised area after pulling the skin a little to one side at the moment of puncture to procure a sliding-valve action between the skin and under-

lying tissues after withdrawal. The resistance of the intercostal muscles and pleura can be recognised at a varying depth (about 2.5 cms. in the absence of overlying muscles) and the needle must be pushed on very cautiously beyond this. The very thin chest wall of an infant must be remembered.

(5) When the operator feels, or suspects, that he has entered the pleural cavity the needle should be carefully steadied while the syringe or aspirator is attached. Uneven jerking of a stiff syringe may cause the needle to penetrate deeper than is desired, and the point of the needle must on no account pierce the lung lest a new source of infection be created.

(6) The use of a fine trocar and cannula such as the Riviere No. 1 A. P. needle obviates some of the drawbacks of a needle with an oblique point.

(7) If fluid is not found at the first point chosen the needle should be withdrawn and re-inserted in another likely spot, after verifying that the first failure was not caused by blockage with clot or soft tissue.

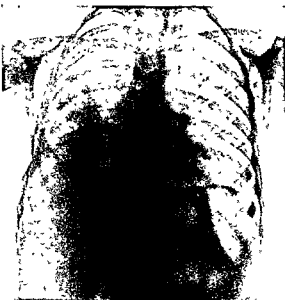
(8) When fluid is found, a specimen is collected in a sterile tube for bacteriological and cytological examination.

(9) The point at which fluid was first encountered is carefully marked and the depth noted at which it was found.

(10) If fluid has collected rapidly or has eluded detection until signs of pressure are apparent so that there is no doubt that a considerable quantity is present, the cavity can be safely entered with a wide-bore needle or trocar and cannula and the whole or a great part of the fluid evacuated with an aspirating apparatus.

injured lung tissue may lay the train for later bronchiectatic changes. The inflamed serous membrane has also a certain, if limited, power of creating granulation tissue, and its contraction helps adhesion at the margins of the opposing pleural layers.

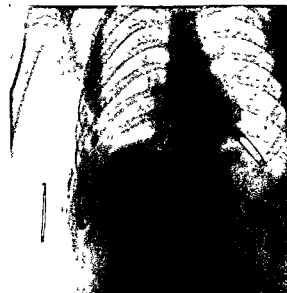
Viewed from any aspect, and faced with all these disadvantages, the propriety of closed drainage cannot be gainsaid, and wherever possible it should be practised, for it is continuously favouring re-expansion of the lung at the same time as the pus is being evacuated.



A.



B.



C.

Fig 1121.—X RAYS SHOWING POSSIBLE RESULT OF OPEN DRAINAGE IN ACUTE EMPYEMA. THE PLEURAL CAVITY BECAME INFECTED FOLLOWING A PNEUMONITIS. ASPIRATION PRODUCED DEFINITE PUS, THE PREDOMINANT ORGANISM BEING THE PNEUMOCOCCUS. OPEN DRAINAGE WAS ESTABLISHED AND PUS EVACUATED, BUT THE LUNG FAILED TO RE-EXPAND, AND A PLEURO CUTANEOUS FISTULA PERSISTED FOR SEVERAL MONTHS. AT A SECOND OPERATION THE ORIGINAL OPENING WAS EXCISED AND SUTURED. AT THE SAME TIME A SMALL INTERCOSTAL CLOSED DRAIN WAS INSERTED IN THE LOWEST PART OF THE CAVITY. IN 10 TO 14 DAYS THE LUNG HAD EXPANDED FULLY.

A. EXTENSIVE RIGHT SIDED EMPYEMA

B. CONDITION AFTER OPEN DRAINAGE. A LARGE DEAD SPACE PERSISTS. CALLUS CAN BE SEEN AT THE SITE OF RIB RESECTION.

C. CONDITION 10 DAYS AFTER CLOSED INTERCOSTAL DRAINAGE. THE LUNG HAS EXPANDED. DRESSINGS ARE VISIBLE OVER THE LOWER CHEST AND THE INTERCOSTAL TUBE CAN JUST BE SEEN CLOSE TO THE VERTEBRAL COLUMN.

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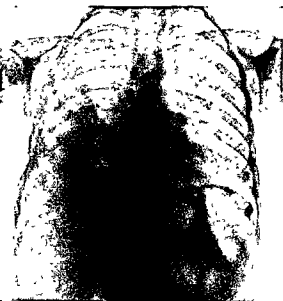
(10) If fluid has collected rapidly or has eluded detection until signs of pressure are apparent so that there is no doubt that a considerable quantity is present, the cavity can be safely entered with a wide-bore needle or trocar and cannula and the whole or a great part of the fluid evacuated with an aspirating apparatus.

TREATMENT

Healing of an empyema is only complete when visceral and parietal pleuræ are in close apposition. The process is not simply one of collapse of the cavity walls as in other parts of the body, but is produced by, and dependent on, a variety of factors. One of the most important of these is the condition of the underlying lung; whether it retains its elasticity or whether as the result of interstitial inflammation it has become rigid and incapable of stretching. When pulmonary fibrosis has become established the cavity can only be obliterated by compensatory falling-in of other structures. Emphysema, mediastinal displacement, diaphragmatic elevation, and indrawing of the ribs all play their part, with the disadvantage that the traction on already

injured lung tissue may lay the train for later bronchiectatic changes. The inflamed serous membrane has also a certain, if limited, power of creating granulation tissue, and its contraction helps adhesion at the margins of the opposing pleural layers.

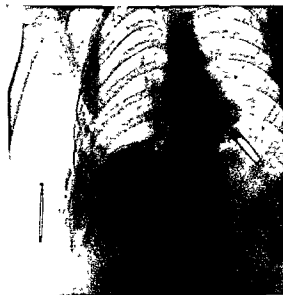
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closure of the wound not relieve distress, oxygen should be administered under pressure. The ordinary gas-bag and mask are quite efficient, the mask being fitted tightly over the face and the bag distended with oxygen to its limits. If much distress is anticipated from the symptoms it is as well from the start to add light gas and oxygen anæsthesia to the local so that intra-pulmonary pressure can be increased and maintained at will. After evacuation of most of the pus a large tube is inserted, such as the flanged tube designed by Tudor Edwards. The muscles are then sutured with catgut, pulling in their retracted margins with tissue forceps to bring them snugly round the tube; a few skin stitches complete the operation and the tube is clipped. With a close-fitting dressing the junction is now air-tight, and on the patient's return

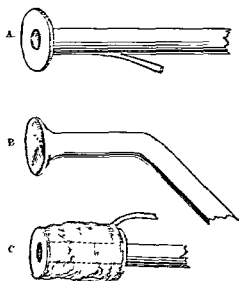


Fig 1127.—EXAMPLES OF WIDE-BORE DRAINAGE-TUBES.

A. TUDOR EDWARDS'. STOUT TUBE WITH A FIRM FLANGE AT RIGHT ANGLES TO PREVENT THE TUBE BEING PULLED OUT OF THE CHEST. A SMALL TUBE IS BUILT INTO THE WALL OF THE MAIN TUBE AND CAN BE USED FOR IRRIGATION WITHOUT HAVING TO DISTURB THE REMAINDER OF THE APPARATUS.

B. DE PEZZER CATHETER ANGLED 2 TO 4 INCHES FROM THE END. THE GREATER PART OF THE BULB IS CUT AWAY SO AS TO LEAVE A RELATIVELY FLAT FLANGE.

C. MORELLI'S. THE PART OF THE TUBE THAT IS TO LIE WITHIN THE THORACIC PARIETES IS SURROUNDED WITH A PNEUMATIC JACKET WHICH IS INFLATED SO THAT LEAKAGE IS REDUCED TO A MINIMUM. IF PRESSURE ULCERATION OCCURS FURTHER INFLATION OF THE JACKET PREVENTS LOOKING AND LEAKAGE.

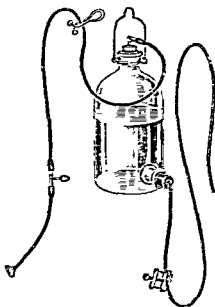


Fig 1128.—ASPIRATION BOTTLE.
(Author's pattern.)

BASED ON PRINCIPLE ILLUSTRATED IN FIG. 1122B. NOTE HANDLE FOR EASY FIXATION TO BED-RAIL, ETC. THE TUBING IS OF WIDE BORE WITH THIN METAL CONNECTIONS, THUS OBVIATING CONTRACTIONS WHICH WOULD OCCUR IF THE ORDINARY GLASS CONNECTIONS ARE USED. THE CAPPED T-PIECE WITH A RECORD FITTING IS FOR IRRIGATION.

to the local so that intra-pulmonary pressure can be increased and maintained at will. After evacuation of most of the pus a large tube is inserted, such as the flanged tube designed by Tudor Edwards. The muscles are then sutured with catgut, pulling in their retracted margins with tissue forceps to bring them snugly round the tube; a few skin stitches complete the operation and the tube is clipped. With a close-fitting dressing the junction is now air-tight, and on the patient's return

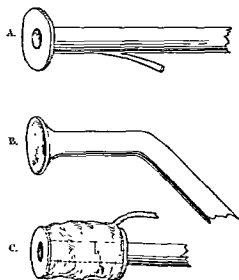


Fig. 1127.—EXAMPLES OF WIDE-BORE DRAINAGE TUBES.

A. TUDOR EDWARDS' STOUT TUBE WITH A FIRM FLANGE AT RIGHT ANGLES TO PREVENT THE TUBE BEING PULLED OUT OF THE CHEST. A SMALL TUBE IS BUILT INTO THE WALL OF THE MAIN TUBE AND CAN BE USED FOR IRRIGATION WITHOUT HAVING TO DISTURB THE REMAINDER OF THE APPARATUS.

B. DE PEZZER CATHETER ANGLED 2 TO 4 INCHES FROM THE END. THE GREATER PART OF THE BULB IS CUT AWAY SO AS TO LEAVE A RELATIVELY FLAT FLANGE.

C. MORELLI'S. THE PART OF THE TUBE THAT IS TO LIE WITHIN THE THORACIC PARIETES IS SURROUNDED WITH A PNEUMATIC JACKET WHICH IS INFLATED SO THAT LEAKAGE IS REDUCED TO A MINIMUM. IF PRESSURE ULCERATION OCCURS FURTHER INFLATION OF THE JACKET PREVENTS LOOSENING AND LEAKAGE.

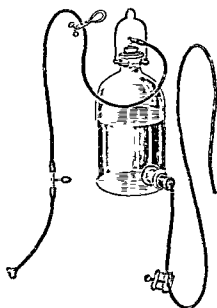


Fig. 1128.—ASPIRATION BOTTLE.
(Author's pattern.)

BASED ON PRINCIPLE ILLUSTRATED IN FIG. 1122B. NOTE HANDLE FOR EASY FIXATION TO BED-RAIL, ETC. THE TUBING IS OF WIDE BORE WITH THIS METAL CONNECTIONS, THUS OBVIATING CONSTRUCTIONS WHICH WOULD OCCUR IF THE ORDINARY GLASS CONNECTIONS ARE USED. THE CAPPED T PIECE WITH A RECORD FITTING IS FOR IRRIGATION.

ut and cleansed. A tightly fitting tube is inserted through a separate stab wound in the most dependent part of the cavity and the main wound is closed by air-tight suturing. The tube is attached to a suction apparatus when the patient has been returned to bed.

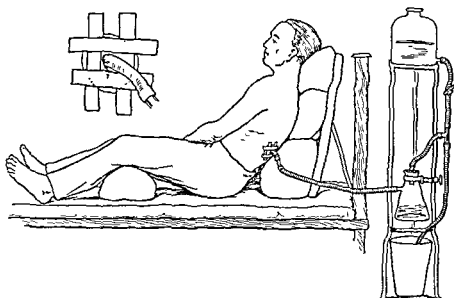


Fig. 1129.—POSITION OF PATIENT IN BED WITH SUCTION DRAINAGE IN PROGRESS. THE OPENING INTO THE CHEST IS PLACED WELL BACK IN THE PARAVERTEBRAL GUTTER. CAREFUL ARRANGEMENT OF PILLOWS PREVENTS THE PATIENT LYING ON THE WOUND AND ALLOWS THE TUBE TO COME TO THE SIDE OF THE BED WITHOUT OBSTRUCTION. A WHITE'S DRAINAGE APPARATUS TAKES UP LITTLE ROOM BY THE SIDE OF THE BED AND IS EASILY CONTROLLED. WATER FLOWING FROM THE BOTTLE AT THE TOP OF THE APPARATUS THROUGH A SMALL BUNSEN PUMP CAUSES SUCTION IN THE CONICAL FLASK WHICH ACTS AS A COLLECTOR OF PLEURAL FLUID.

C. (i) *Open Drainage* only differs from rib resection by the omission of suction. If required a larger opening can be made. Small and moderate-sized empyemata, especially those which are well established and may almost be considered chronic, undoubtedly do well for a time with open drainage, but convalescence is always unduly prolonged and the cortex of the lung is often markedly fibrosed before the sinus is finally obliterated.

On the other hand, it must be admitted that many "closed" systems become "open" unless careful attention is paid to the skin-tube junction.

(ii) *Open Drainage and Tamponade* is rarely required, but in cases of extreme virulence free incision may be necessary as a life-saving measure. Packing of gauze into the pleural cavity helps to stabilise the mediastinum. This form of operation is, however, hardly ever practised in acute cases though its use in chronic cases covers a wide field.

The lines of guidance for the treatment of a case of acute empyema may be best indicated by one or two illustrations :

Metapneumonic empyema commonly owes its origin to lobar pneumonia, and the worst effects of the illness are apparently over

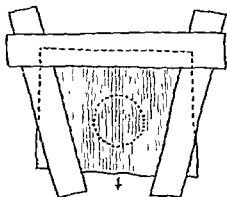


Fig 1130—METHOD OF ALLOWING DRAINAGE THROUGH AN OPENING IN THE CHEST WALL AND AT THE SAME TIME PREVENTING ADMISSION OF AIR. THE OPENING (SUCH AS IS LEFT AFTER REMOVAL OF A WIDEBORE TUBE) IS COVERED WITH A SHEET OF THIN RUBBER WHICH IS MADE ADHERENT TO SKIN WITH MASTISOL OR COLLODION AT THE EDGES, BUT LEAVING THE LOWEST MARGIN FREE. STRAPPING OVER THE EDGES ASSISTS THE CLOSURE, THE LOWEST BORDER STILL BEING LEFT FREE. DRESSINGS BELOW THE RUBBER CATCH ANY DISCHARGE THAT EMERGES. AIR WILL BE EXPELLED ON COUGHING BUT NOT ALLOWED TO RE-ENTER.

before the presence of pus in the pleura is recognised or even suspected. Exploration reveals thick pus and a marked tendency to adhesions and localisation. The pneumococcus is the predominant organism. Actually the pus in the earliest stages is thin, but the diagnosis of empyema is not usually made until it is thick. Should, however, the fluid withdrawn be thin, aspiration should be performed every two or three days. In a very few cases this effects a cure, but more commonly after one or two aspirations the pus is definitely viscous, showing that the infective process is advancing. No definite rule can be laid down for the moment to change over to continuous drainage, but it can be taken that if a

specimen of the pus is left in a test-tube and if a sediment of three-quarters of its volume remains after twenty-four hours, the pleura should then be drained. Irrigation of the pleura is still an open question; it should certainly not be contemplated for at least four or five days after operation. Normal saline is useful to remove debris and to gauge the toleration of the pleura for a start. Afterwards warm eusol or Dakin's solution may be used as a disinfectant for some time, but

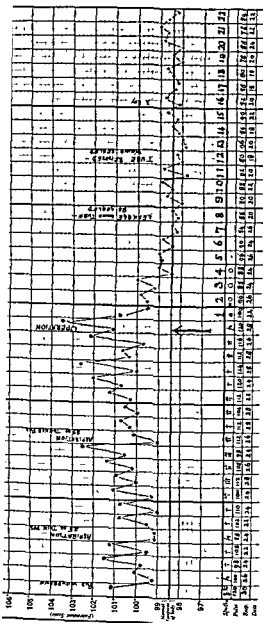
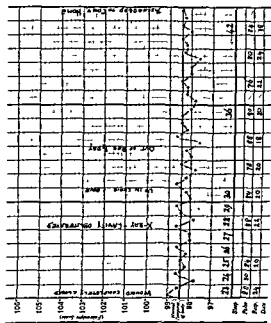


Fig. 131.—TEMPERATURE CHART OF PATIENT WITH CHARGE RIGHT EMPYEMA FOLLOWING BRONCHOPNEUMONIA. PNEUMOCOCCUS THE PREDOMINANT ORGANISM. ASPIRATION PERFORMED ON TWO OCCASIONS UNTIL PUS WAS TOO THICK FOR EASY WITHDRAWAL. RIB RESECTION AND CLOSED DRAINAGE WAS FOLLOWED BY DEFINITE IMPROVEMENT. A LEAK ROUND THE TUBE OCCURRED ON THE 8TH DAY AND THE JUNCTION RESEALED. TUBE WAS REMOVED ON THE 12TH DAY AND THE EMPYEMA CAVITY OBLITERATED BY THE 21ST DAY. THE WOUND WAS COMPLETELY CLOSED BY THE 23RD DAY.



not too long on account of its tissue solvent action. Drainage is free for a week or ten days and need not give rise to anxiety if it continues for three weeks, but after that exploration for an undetected pocket of pus is advisable. When drainage is reduced to a minimum the tube can be removed, but the proper moment can only be judged from a variety of evidence; X-rays may show a major degree of obliteration of the cavity, and its volume can be fairly accurately measured by injecting saline until it overflows; a soft bougie, very carefully handled, gives the depth of the cavity. With a capacity of two to three ounces and only a slight discharge the tube may be removed and the wound covered with a dressing and a sheet of rubber which is secured by adhesive to the skin, except for a small space at the lower margin. Healing is usually complete in from three to four weeks. Breathing exercises should be practised from the start of drainage, together with auxiliary measures of blowing water from one Wolff bottle to another, playing small wind instruments, etc., supplemented by inhalations of CO_2 , all of which aim at re-expansion of the collapsed lung.

Synpneumonic empyema demands different treatment. Exudation occurs during the course of the pulmonary inflammation, which in its most virulent form is a streptococcal lobular pneumonia. The pleural sac is filled with a large quantity of clear or turbid fluid and signs of pressure are added to a grave toxæmia. This fluid does not become definitely purulent for from two to four or five weeks. The rapidity of its outpouring makes active treatment imperative. Aspiration for the relief of pressure may draw off pints of almost clear fluid, and must be repeated every three or four days or more often if signs of distress are evident. Rib resection and wide-tube drainage must not be contemplated until the pus has thickened, but intercostal drainage through a small tube may be substituted for frequent aspiration and may tide things over; indeed, in a few cases it may even obviate resection. Subcutaneous infection is not infrequent from contamination of the needles or cannulæ on withdrawal and is relieved by small incisions; the pleura must not be opened at this stage. The main danger of a synpneumonic empyema is exhaustion, for unlike the metapneumonic type, in which the lobar pneumonia is cured, the patient has to withstand the toxæmia of a persisting streptococcal lobular inflammation.

Bilateral empyema is practically confined to children, and from the prolonged course of the pulmonary condition has to be regarded more

in the light of the synpneumonic form in spite of its probable pneumococcal origin. The mortality in very young children is undoubtedly heavy. Aspiration of both sides is performed, sometimes at the same sitting, but if not, taking the worst side first. When pus becomes too thick for easy withdrawal free intercostal drainage is substituted for aspiration, the wide interspaces in children rendering resection of rib unnecessary. Bilateral drainage can be practised, and though sounding heroic is more successful than draining first one side and then the other. Children are difficult to nurse in the sitting posture, and it is easier to allow them to lie and pass the tube or tubes between the sections of a divided mattress into a bucket of water on the floor.

Empyema following an infected infarct is at first treated somewhat on the lines of the synpneumonic type—aspiration followed by continuous drainage—but pus thickens more rapidly.

When the pleura is infected by the rupture of a pulmonary abscess the effects may be very diverse; some cases require immediate incision and drainage to overcome the virulence of the infection, while others only need aspiration and at the same time the lung abscess obtains satisfactory drainage.

Interlobar empyema is treated on similar lines to a chronic lung abscess. If the pleura is free it must be rendered adherent by packing before attempting drainage. Identification of mediastinal and diaphragmatic collections may be very difficult, and if a long-standing case is to be explored the surgeon must be ready to carry out drainage as soon as pus is found, without disturbing the aspirating needle.

Empyema necessitatis is a condition in which pus finds its way to the surface through an interspace after breaking through the pleural confines. The implication is that treatment has been unduly delayed or the presence of pus in the chest has gone unrecognised. Simple incision will relieve a collection of subcutaneous pus which has not already found a fistulous outlet through the skin. It may be necessary to enlarge the opening in the parietal pleura if drainage is not adequate.

Rupture of an empyema into a bronchus is an accident which early treatment will avoid. The contents of an empyema are sometimes coughed up completely with a resulting cure, but in general the risk of bronchiectasis and abscess formation is such that it is advisable to drain the pleura externally in nearly every case.

CHAPTER III

CHRONIC EMPYEMA

THE term chronic empyema can be used to cover a variety of conditions of long-standing pleural infection. At one extreme there are acute cases which discharge pus for more than four weeks and thereby fall under the heading of chronic ; while at the other extreme there are pleural abscesses which are intermittently open over a period of years.

The more common forms of chronic empyema can be divided into several classes :

(1) Recent cases in which inadequate drainage is the principal cause. This class generally constitutes a reflection on the treatment of the acute condition.

(2) Long-standing cases equivalent to abscess cavities with abnormally rigid walls. A superficial sinus may or may not be present. Re-infection from the pleural walls occurs at intervals, but thorough cleansing resolves the problem of treatment into obliteration of a dead space.

(3) Cases similar to the last mentioned group, but in which there is some obvious focus maintaining infection of the cavity (e.g. pleuro-bronchial fistula). A chronic inflammatory state of the underlying lung, as extreme fibrosis or bronchiectasis, may hinder collapse of the pleural abscess and tend to aggravate the infective process.

(4) Tuberculous infection of the pleura which is considered in a separate chapter (see page 2162).

(5) Cases secondary to carcinoma and actinomycosis in which treatment is mainly palliative as the primary infection can rarely be eradicated.

Causes that may lead to the production of chronic empyema may be briefly summarised as follows :

(1) Inadequate drainage :

(a) Too small an opening for free escape of pus.

- (b) The opening too high or too far forward, with the result that a pool of pus is left below the site of drainage.
- (c) Removal of the tube before the pleural infection has been controlled. When the tube is removed at the correct time the wound heals quickly and without trouble, but if removed too early the closure is incomplete and a sinus with pouting granulations persists.



Fig. 1132.—X-RAY OF CHRONIC EMPYEMA. ELLIPTICAL SHADOW IN LATERAL ASPECT OF THE LEFT CHEST INDICATES THE SITUATION OF THE EMPYEMA CAVITY. LESS DENSE SHADOW OVER THE LUNG FIELD IS PRODUCED BY THICKENED PLEURA AND PULMONARY FIBROSIS. NOTE THAT LEFT DIAPHRAGM IS DRAWN UPWARDS. THE CONDITION AROSE AS THE RESULT OF ESTABLISHING DRAINAGE LATE IN THE ACUTE STAGE OF THE EMPYEMA. CURE WAS EFFECTED BY LOCALISED RIB RESECTION AND DRAINAGE.

(2) Instituting drainage too late in the acute stage. The underlying lung tends to become covered with a resistant fibrinous layer which impedes expansion of the lung and hinders obliteration of the empyema space.

(3) Foreign bodies remaining in the cavity, e.g. gauze swabs, drainage-tubes, safety-pins, or sequestra. Masses of lymph which have not been expelled remain a potential source of infection, though as a rule proteolysis hastens their disintegration.

(4) Failure to recognise the true origin of the infection: for example, a case diagnosed as being of simple pyogenic origin fails to respond to treatment because pleural tuberculosis or pulmonary

carcinoma was the real cause at the back of the condition. Further, there are cases associated with deep-seated abscesses which persist because the primary source of infection is not removed—e.g. a pulmonary abscess ruptures into the pleura and intermittently infects the pleura until the abscess itself is cleared up.

The duration of an empyema determines largely the appearance of the cavity and its walls. Recent cases show firm localising adhesions and granulation tissue with pus whose character is variable. A superficial sinus is usual and the daily quantity of discharge may be considerable. In long-standing cases the walls are much thicker and rigid owing to fibrosis, and frequently attain a surprising thickness almost of cartilaginous consistency. The presence of a permanent sinus is by no means essential, and pus contained in the cavity usually has a stale and foetid odour. Cholesterol crystals are indicative of prolonged encystment of the empyema.

Variations in the signs and symptoms of a chronic empyema are not unexpected, and, if the cavity is draining, signs of general toxæmia may not be obvious. Cyanosis, emaciation and dyspnoea are, however, common symptoms, and clubbing of the fingers and toes is noticeable. The existence of cough and sputum is largely dependent on the state of the lung underlying the empyema, though an irritative cough purely due to pleural inflammation may persist. The physical signs in the chest are masked by the thickness of the pleura, which is also responsible for lack of movement and poor expansion of pulmonary tissue.

In the presence of a sinus, investigation of the pus should be the first consideration, realising at the same time that secondary organisms will have invaded the empyema cavity. With a closed abscess, aspiration will have to be attempted as a preliminary to treatment as much for the purpose of localisation as for examining the pus. Many of these closed cases contain very little pus, and the passage of foul gas along the needle may be the only indication that the cavity has been entered. The absence of organisms in the pus should not necessarily lead to the conclusion that the empyema is of tuberculous origin as there are quite a number of old cases, particularly pneumococcal, which become sterile with time.

A persistent cough with sputum leads to the suspicion of coincident lung infection or a pleuro-bronchial fistula. Fibrosis and secondary bronchiectasis are not uncommon, and it is advisable to investigate the state of the lung with intra-tracheal lipiodol if these conditions

are suspected, as treatment will have to aim at their relief in addition to that of the empyema. Early external drainage in cases of pleuro-bronchial fistula is an important preliminary.

Injection of lipiodol into the empyema affords a useful means of estimating the size of the cavity radiologically.

One of the principal complications in the course of a chronic empyema is that of pus or air-embolism. If air or infective material



Fig. 1133.—X-RAY OF CHRONIC EMPYEMA FILLED WITH LIPIODOL. A LEFT-SIDED EMPYEMA CAVITY OF LONG DURATION HAS BEEN FILLED WITH A CONTRAST SOLUTION. NOTE LOCULATION AND POCKETING. DRAINAGE AND EXTENSIVE RIB RESECTION WERE NECESSARY TO CLOSE THE CAVITY.

ruptures into a pulmonary vein in any quantity embolism or abscess formation may be expected in the brain. The danger of this is very real, particularly if the contents of the empyema are submitted to pressure.

When considering *treatment* two distinct factors have to be borne in mind :

- (1) Drainage and disinfection of the cavity.
- (2) Closure of the cavity.

It depends on individual circumstances as to whether these procedures can be combined at operation or whether they have to be taken separately. In a small cavity not grossly infected, operative treatment can be successfully carried out in one stage, but most cavities turn out

tissues and parietal pleura can be freely removed to allow the covering flap to fall in on the underlying lung. The Estlander type of operation, in which short lengths of rib are removed subperiosteally, usually fails if the empyema cavity is at all extensive on account of the rigidity of the intercosto-pleural layer.

The *Schede Thoracoplasty* is the classical operation for a long-standing empyema cavity (Empyemresthöhle), and consists of resection of the ribs and parietal pleura lying over the cavity. The incision takes the form of a huge U starting at the lower pectoral border in the anterior axillary line, crossing the tenth rib in the posterior axillary line and terminating between the spine and posterior border of the scapula about the level of the second or third rib. All superficial muscles in the line of the incision are divided and the flap is turned up over the inferior angle of the scapula. Bleeding at this stage is free. A large area of the thoracic cage is now exposed and following excision of a convenient length of rib the cavity is explored digitally and the extent of the operation planned. Ribs are most simply removed by dividing them in the middle and by dissecting out the anterior and posterior parts separately in order to cut them close to the costal cartilage and angle of the rib respectively. The ribs may be found to be irregular and, if previous drainage has been practised, fused into a shapeless plaque of bone; also if there has been any infection they may be spongy and easily splintered or unduly hard to cut owing to sclerosis. Having removed all necessary bone the "soft" roof over the cavity is cut away entirely. The thickness of the parietal pleura has already been commented on, and it is unusual to find that the intercostal vessels bleed as freely as they do normally. Ligature of all bleeding points should, however, be practised, and it should be realised that the toughness of the tissues prevents accurate application of the Spencer-Wells type of forceps in many instances. Injection of novocaine into

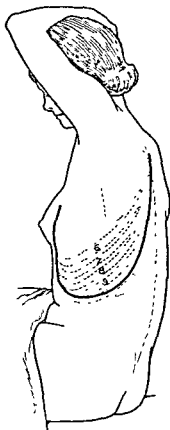


Fig. 1134.—CLASSICAL LINE OF INCISION FOR THE SCHEDE TYPE OF THORACOPLASTY IN CASES OF EXTENSIVE CHRONIC EMPYEMA. WHEN THE SKIN-MUSCLE FLAP HAS BEEN TURNED UP THE RIBS ARE EXPOSED FOR RESECTION AND, BY RETRACTING HEAVILY ON THE SCAPULA, RIBS BENEATH IT CAN BE REACHED IF NECESSARY. AN OPERATION OF THIS MAGNITUDE IS ACCOMPANIED BY SEVERE SHOCK AND CONSIDERABLE MUTILATION.

to be larger than at first suspected, and several sessions may be necessary to effect complete cure.

(1) The first step in treatment is to cleanse the empyema cavity, and this is best done by establishing *free drainage* at the lowest point of the cavity. Resection of one or more ribs is carried out over a reasonable length, and free excision of dense tissue covering the cavity should be made. This tissue may even be hard to cut with a knife and is often an inch and a half in thickness. Exploration of the cavity for foreign bodies or concealed loculi must be thorough. The need for a big opening is emphasised because the skin and surface wound tend to heal up more rapidly than is desirable.

Open drainage is the only course possible in these cases as the walls of the cavity are too resistant to be influenced by suction.

Irrigation is an asset in obtaining disinfection of these spaces, but is forbidden when a pleuro-bronchial fistula is present or is suspected. Introduction of methylene blue solution into the cavity will indicate the presence of a fistula by its appearance in the sputum. Eusol is satisfactory but must not be run in under any pressure, and dilute solutions of antiseptic aniline compounds have a good effect in dissolving some of the dense covering over the lung surface.

(2) *Closure of the cavity.* Drainage appreciably diminishes the size of the empyema, and in many cases healing actually occurs, but in the remainder a residual space of variable capacity persists. The structure of the cavity prevents collapse since its outer wall is the rigid thoracic cage and the inner consists of thick or toughened pleura overlying lung which may itself be indurated or fibrotic. The alternatives of treatment, therefore, must be to collapse the chest wall on to the lung or to bring the lung out to the chest wall. These objects can be obtained by :

- I. Removal of part of the chest wall—particularly ribs. (*Thoracoplasty*.)
- II. Excision of thick end of visceral pleura and re-expansion of lung. (*Decortication—Discission*.)

These principles can be used singly or combined, and as a measure of safety each operation should be associated with drainage.

I. Interventions on the chest wall should err rather on the side of being too generous than too limited. In addition to bone intercostal

tissues and parietal pleura can be freely removed to allow the covering flap to fall in on the underlying lung. The Estlander type of operation, in which short lengths of rib are removed subperiosteally, usually fails if the empyema cavity is at all extensive on account of the rigidity of the intercosto-pleural layer.

The *Schede Thoracoplasty* is the classical operation for a long-standing empyema cavity (*Empyemresthöhle*), and consists of resection of the ribs and parietal pleura lying over the cavity. The incision takes the form of a huge U starting at the lower pectoral border in the anterior axillary line, crossing the tenth rib in the posterior axillary line and terminating between the spine and posterior border of the scapula about the level of the second or third rib. All superficial muscles in the line of the incision are divided and the flap is turned up over the inferior angle of the scapula. Bleeding at this stage is free. A large area of the thoracic cage is now exposed and following excision of a convenient length of rib the cavity is explored digitally and the extent of the operation planned. Ribs are most simply removed by dividing them in the middle and by dissecting out the anterior and posterior parts separately in order to cut them close to the costal cartilage and angle of the rib respectively. The ribs may be found to be irregular and, if previous drainage has been practised, fused into a shapeless plaque of bone; also if there has been any infection they may be spongy and easily splintered or unduly hard to cut owing to sclerosis. Having removed all necessary bone the "soft" roof over the cavity is cut away entirely. The thickness of the parietal pleura has already been commented on, and it is unusual to find that the intercostal vessels bleed as freely as they do normally. Ligature of all bleeding points should, however, be practised, and it should be realised that the toughness of the tissues prevents accurate application of the Spencer-Wells type of forceps in many instances. Injection of novocaine into



Fig. 1134.—CLASSICAL LINE OF INCISION FOR THE SCHEDE TYPE OF THORACOPLASTY IN CASES OF EXTENSIVE CHRONIC EMPYEMA. WHEN THE SKIN MUSCLE FLAP HAS BEEN TURNED UP THE RIBS ARE EXPOSED FOR RESECTION AND, BY RETRACTING HEAVILY OF THE SCAPULA, RIBS BENEATH IT CAN BE REACHED IF NECESSARY. AN OPERATION OF THIS MAGNITUDE IS ACCOMPANIED BY SEVERE SHOCK AND CONSIDERABLE MUTILATION.

intercostal nerves allays some of the shock that is encountered during excision of tissue. When the cavity has been laid freely open the surface is inspected for pockets of pus and wiped over with gauze. The skin flap with attached superficial muscles is then replaced, but it will be seen that in some cases the floor of the cavity cannot be fully covered if the flap is to lie comfortably against it. In these cases suture of the flap over the upper part of the wound is the primary consideration, and the lower raw area that is left will either granulate over or can be covered by Thiersch graft. Free drainage at the lowest part of the wound is essential.

The shock produced by an operation of this magnitude is severe in the extreme, and the operation has nearly always to be split up into stages according to the ability of a toxic patient to withstand the procedure. The reaction after operation is often marked, and attention must be paid to keeping the skin flap pressed on to the floor of the wound—the inclusion of sponges or “sorbo” material in the encircling dressings is an asset in this respect. The deformity produced by the Schede operation is very great, the patient appearing as if he had been cut away under the armpit; suppuration interferes with healing of the superficial muscles and the scapular function is generally impaired. Scoliosis with the concavity towards the side of operation is usual and the abdominal muscles may “balloon” as a result of paralysis of the intercostal nerves.

Excision of thickened parietal pleura contributes largely to the shock occasioned by the operation just described. There is consequently some advantage in a similar type of procedure in which only bone is actually cut away. The operation is the same until rib resection is completed: the thick pleura over the empyema is not excised, but is simply incised so as to form a flap or flaps which will fall into the base of the cavity without interfering with drainage. The pleural layers now lie in apposition, and when infection has been eliminated will become adherent with obliteration of the empyema space.

II.¹ *Decortication* aims at stripping off the thickened visceral pleura in the hope that re-expansion will occur once the restriction is removed. Sometimes it is possible to obtain full expansion without having recourse to rib resection, but more often the operations are combined and decortication used to supplement a limited thoracoplasty.

The operation of decortication consists of exposing the cavity freely and incising the thick visceral pleura until the blue-grey surface of lung appears. The incision gapes and with careful blunt dissection the edge

of the pleural layer is raised. This generally comes away with surprising ease in a clean sheet, but at odd points firm adhesion to lung makes it difficult to avoid injury to parenchyma. Theoretically this might be regarded as a serious complication, but beyond a little frothy bleeding it is rare for anything untoward to happen. In satisfactory cases the lung balloons out, as the restricting tissue is removed, in a remarkable manner. To encourage the expansion that has been obtained a wide suction drain is preferable to any other form.

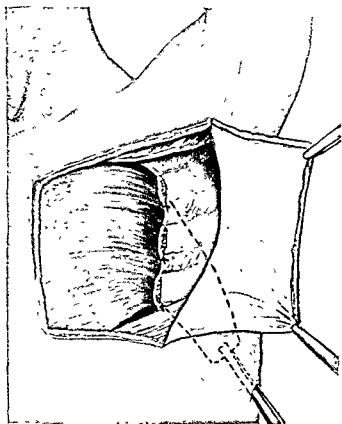


Fig. 1135.—METHOD OF USING MUSCLE TO ASSIST IN FILLING A LARGE CHRONIC EMPYEMA CAVITY. AFTER TURNING BACK A SKIN FLAP PART OF THE PECTORALIS MAJOR IS FREED CLOSE TO ITS INSERTION. THE DEAD SPACE IS EXPOSED BY RIB RESECTION AND THE MUSCLE DRAWN INTO THE SPACE BY FORCEPS INTRODUCED THROUGH A SEPARATE WOUND. THE FREE END OF THE MUSCLE MUST BE FIRMLY FIXED TO PREVENT RETRACTION. THE SITUATION AND SIZE OF THE EMPYEMA DETERMINES THE SUITABILITY OF USING MUSCLE.

Decortication for small cavities is not recommended; indeed, the preliminary drainage and irrigation often render the pleura so thin that the operation is impracticable. Moreover, if there are indurative changes in the lung itself the advantages offered by this procedure are nullified. When decortication is not possible for practical reasons the cross-hatched incisions of *discission* into the thick pleura allow a little more expansion to the lung on account of their gapping.

The use of *muscle grafts* to fill in a dead space is occasionally practised once the infection has been satisfactorily controlled (Kirschner). The pectoralis major can be turned in from in front and strips of latissimus dorsi laid in from behind without interfering with the blood supply of the pedicled grafts so cut. It is important to fix the free margin of the graft into the cavity to prevent its possible retraction. This procedure is not ideal, but has the merit of helping to obliterate a chronic cavity without causing the mutilation and deformity associated with an extensive thoracoplasty.

Finally there are a certain number of cases which fail after trial of the above methods. For these, excision of all superficial tissue and packing is the only alternative. The raw area is left to granulate over, which it may do quite rapidly with or without the help of Thiersch grafting. The disadvantage of practising this over a wide area is that a soft unprotected zone is left directly over lung. If the margins are guarded by rib ends this "weak spot" is not at a great disadvantage, but the bulge on coughing and liability to injury constitute a definite disability. In all operations of the thoracoplastic order for chronic empyema the deformity is unsightly and the secondary effect—scoliosis—unpleasant if not actually crippling.

A few examples of chronic empyemata may serve to indicate the selection of treatment:

Small recent cavity. Exploration followed by a free drainage opening may suffice. Irrigation can be employed if the pleura is at all thickened.

Small long-standing cavity. Excision of all tissues over the cavity and packing with gauze may be the shortest and most simple way of effecting a cure. With a cavity the size of the fist less mutilating procedures may be preferred; removal of overlying ribs with mobilisation of the parietal pleura and drainage should be effective.

Moderate-sized cavity. Preliminary incision and drainage followed by irrigation. When sepsis is controlled a more extensive exposure with rib resection can be made, and if the deep surface looks suitable, decortication should be attempted. Quite often the first attempt at closure does not succeed; apparently effective collapse has been obtained, but some slight exacerbation of infection (even after skin healing) is not infrequent. After a suitable interval the extent and

size of the residual space is estimated and free laying open and packing allows healing by granulation to bring about the final closure.

Large-sized cavity. Drainage and irrigation is again the preliminary step and the actual closure should not be hurried. An endoscope (cystoscope) affords a useful means of examining the interior of the space and estimating its condition. Collapse by Schede thoracoplasty is the basis of closure, though decortication may help matters in parts. Several stages may be necessary, but the extent of any one operation can only be judged by the condition of the patient at the actual time. After the planned operation is complete some supplementary measures may be necessary to effect healing.

Cavity with Pleuro-bronchial Fistula. Again, free drainage must be the preliminary, but irrigation is prohibited. Sometimes the fistula heals under this treatment, and, failing this, closure of the cavity will suffice in other cases. If the underlying lung is the site of bronchiectatic changes the decision has to be made as to whether the lung tissue should or should not be incised with the object of establishing bronchial drainage.

CHAPTER IV

TUBERCULOUS EMPYEMA

EMPYEMA of tuberculous origin may obviously be caused by extension from a phthisical lesion as in a spontaneous pneumothorax or during the course of artificial pneumothorax treatment, but there are some cases in which a pyogenic origin is suspected and the diagnosis of tuberculosis is only made by the presence of an occasional acid-fast bacillus or persistent sterility of the contained pus or by the presence of tuberculous granulations in the wall of the cavity.

Tuberculous empyemata may be classified as follows :

- (1) Clear serous exudate, exemplified by the effusion that may occur in the course of pneumothorax treatment.
- (2) Purulent effusion—not contaminated with pyogenic organisms.
- (3) Mixed infection, in which pyogenic organisms add their detrimental effect to the tuberculous condition.

The first group requires no comment apart from the fact that aspiration is occasionally needed for its control. Gas replacement may be advisable in cases under pneumothorax treatment, and great care must be taken to keep the effusion sterile.

Cases of *mixed infection* commonly result from the rupture of a secondarily infected tuberculous focus into the pleural cavity. The severity of the condition is variable. In some instances a mild staphylococcal infection is introduced by repeated aspiration into a hitherto sterile effusion. At the other extreme the virulence and shock produced by rupture of an abscess may be rapidly fatal. Treatment in the more severe cases must be directed against the pyogenic moiety of the infection, and for this purpose drainage must be instituted. Aspiration even with pleural lavage generally fails to produce cure, and resort must be had to free incision, preferably with rib resection. Whether drainage should be open or closed depends on the tuberculous factor in the lung, i.e. whether collapse or expansion of the lung is better for the patient; the former demanding open, the latter closed drainage. The gravity of

these mixed infections can be gauged by the fact that the mortality approaches 80 per cent. When the secondary infection has been controlled the condition is treated as a pure tuberculous empyema.

The treatment of *pure tuberculous* empyemata has to be discussed, as with other forms of empyema, with reference to arrest of the infection and closure of the cavity.

Closure of the cavity is the more difficult problem, chiefly because of its size, for the average case involves the greater part of the pleural sac. Strict attention to care of the general condition of the patient, as obtains in sanatorium regime, is essential. Pus as it collects should be aspirated, but continuous drainage in this, as with other sterile cold abscesses, cannot be countenanced on account of the risk of introducing secondary infection.

The state of the underlying lung has to be taken into account because of the primary phthisical nature of the condition. The pleural and pulmonary factors cannot be separated, and if it is held that the collapse of lung should be maintained, no matter whether it was produced intentionally by artificial pneumothorax or accidentally by a spontaneous pneumothorax, all methods of treatment must be designed so as not to interfere with this.

The headings under which principles of treatment can be classified are :

- (1) Removal of pus by aspiration, with or without gas replacement.
- (2) Disinfection of the cavity by lavage, oleothorax or gelatinothorax.
- (3) Collapse of the cavity by extensive thoracoplasty or by re-expansion of the lung.

(1) There is little to add concerning *Aspiration* beyond what has been said previously. If gas replacement is employed with the view of keeping the intra-pleural pressure steady an artificial pneumothorax needle is entered into the chest anteriorly above the level of the fluid. As aspiration proceeds air is admitted and pressures controlled by observing the manometer readings. It is advisable to inject a little iodine solution along the track of the aspirating needle on withdrawing, in order to obviate the danger of fistula formation.

(2) *Lavage* of the pleural sac with mercurochrome, methylene blue and similar disinfectants may retard the production of pus and occasionally in mild cases this method alone has been successful. The

presence of a pleuro-bronchial fistula must be excluded before the operation by observing the constancy of the pressure readings.

Oleoethorax is effective in some mild cases following artificial pneumothorax and in similar instances gelatinothorax is said to be even more satisfactory. This latter measure consists of injecting gelatin and acriflavine into the chest. The gelatin mixes more freely with the pleural fluid than oil and consequently the acriflavine has a better chance of disinfecting the cavity.

(3) *Obliteration* of the cavity can only be contemplated when the infection appears to be controlled and when the condition of the patient is good enough to withstand surgical intervention.

Re-expansion of the lung would be an ideal procedure if it were not for the facts that some unarrested lung focus may be activated, and that in long-standing cases induration and fibrosis may impede this expansion. The alternative and more commonly practised procedure is to collapse the chest wall on to the cavity by an extensive paravertebral thoracoplasty. When the cavity is large the amount of rib resected has to be greater than in the average phthisical case, and supplementary measures such as phrenic evulsion and accessory rib resection are usually required. Performing the operation in stages it is often possible to reduce the empyema cavity to a small space of 2-3 oz. capacity; this space can be further reduced by intercostal drainage and iodine lavage.

At no time during any of the collapse procedures can aspiration be discarded. Each measure of collapse raises the pressure on enclosed fluid which must be removed to prevent distress or other complications. Throughout treatment the site for aspiration should be selected so as to avoid contamination of any possible field of operation.

CHAPTER V

PULMONARY EMBOLISM

THE opportunity for removal of an obstructive pulmonary embolus by Trendelenburg's operation is so rare that it can hardly be classed as a routine surgical procedure, but the nine successful cases recorded among one hundred and twenty-four attempts justify inclusion of the endeavour to relieve this otherwise fatal condition.

The diagnosis in most cases is definite and unmistakable, and is only rarely confused with acute heart failure, coronary embolus, acute internal hæmorrhage, or cerebral embolism. Suddenly the blood supply to the lungs is cut off; no blood enters the left heart and aorta; the systemic blood-pressure falls to zero; the brain is void of blood, life has practically ceased. The sudden onset without warning is dramatic; the patient craves for air, gasps for breath, looks terror-stricken and fearfully anxious, is instantly bathed in cold sweat and is unconscious in a minute. The pulse-rate can be felt to be failing rapidly until it is imperceptible. Convulsions and loss of corneal reflex may be associated, and the terminal expression of the heart's activity is noticed, i.e. a flicking pulsation in the veins at the base of the neck.

The average time between the onset of obstruction and death is 10-20 minutes, though there are recorded cases in which the duration was only 3 minutes, and some in which it extended to 9 or 10 hours.

Non-obstructive forms of embolus are fortunately not often confused with the obstructive clot, which is solidly impacted in the stem or two main branches of the pulmonary artery, and tends to a prolonged course usually leading to one or more pulmonary infarcts. Pain in the side, dyspnœa, cyanosis and hæmoptysis are the most noticeable symptoms, making the condition difficult to differentiate from lobular pneumonia.

If *treatment* of pulmonary embolism is to be attempted several essentials have to be observed:

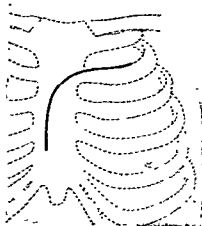
- (1) Immediate recognition of the condition.
- (2) In institutions it should always be possible for there to be someone available who knows the technique of the operation.

- (3) Instruments kept sterilised and in a drum for immediate transport to the bedside.
- (4) Observation of the patient if and until pulse is imperceptible.

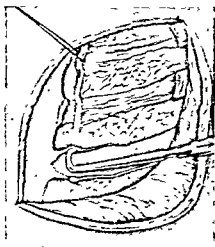
Operation can be undertaken without anaesthesia as the patient is practically unconscious. Bleeding is negligible, and while there is no need for frantic haste time should not be wasted. Five to ten minutes are allowed for the operation, and only if consciousness returns is anaesthesia needed.

Other points in the technique of the operation which is described in the accompanying diagrams are :

- (1) Removal of costal cartilages 2 and 3, or 3 and 4, gives adequate exposure.
- (2) Stripping back of the left pleural sac is not always easy, but if the sac is torn the tear should be covered by a swab for the time being and sewn up later.
- (3) The pericardium lies deeply placed between the two anterior lips of the pleural sacs and loose cellular tissue lies over it. This tissue is picked up close to the mid-line and incised until the serous lining of the pericardium is exposed.

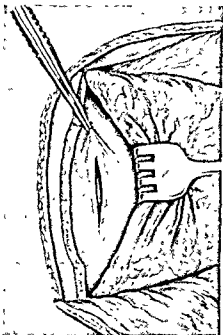


A. SKIN INCISION.

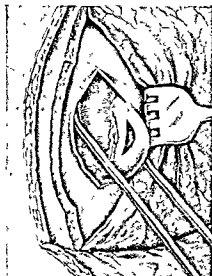


B. SKIN AND MUSCLE HAVE BEEN REFLECTED. COSTAL CARTILAGES 2 AND 3 HAVE BEEN RESECTED AND THE PERICARDIUM IS BEING STRIPPED FROM THE 4TH. THE INTERNAL MAMMARY ARTERY LYING CLOSE TO THE STERNUM HAS A LIGATURE PASSED ROUND IT.

Fig. 1136a.—STAGES IN THE OPERATION FOR REMOVAL OF PULMONARY EMBOLI.



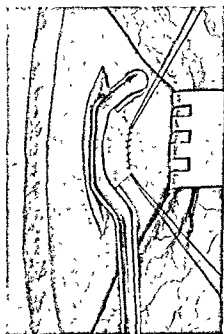
C. PLEURA AND RIGHT LUNG MARGIN ARE RETRACTED AND, AT A LEVEL DEEPER THAN SHOWN, THE PERICARDIUM IS HELD UP AND INCISED.



D. THE AORTA AND PULMONARY ARTERY ARE PULLED OUT OF THE PERICARDIUM WITH A PIECE OF RUBBER TUBING PASSED THROUGH THE TRANSVERSE SINUS BY MEANS OF A TRENDLENBURG SOUND (SEE FIG. 1137). THE PULMONARY ARTERY IS INCISED.



E WHILE THE RUBBER TUBING CONTROLS BLEEDING THE INCISED MARGINS OF THE ARTERY ARE HELD OPEN WITH FORCEPS. THE CLOT IS BEING EXTRACTED.



F THE INCISION IN THE ARTERY IS CONTROLLED BY SPECIAL FORCEPS WHICH DO NOT OBSTRUCT THE BLOOD FLOW COMPLETELY. SUTURES OF VERY FINE VASELINED SILK ARE INSERTED.

Fig. 1136b—STAGES IN THE OPERATION FOR REMOVAL OF PULMONARY EMBOLUS.
(From Sellors' *Surgery of the Thorax*, Constable.)

- (4) A finger passed into the pericardium and transverse sinus helps to guide the Trendelenburg sound round the vascular pedicle.
- (5) The vascular pedicle should be occluded by tubing for as short a time as possible. In successful cases 45-60 seconds' occlusion has not led to ill-effects.

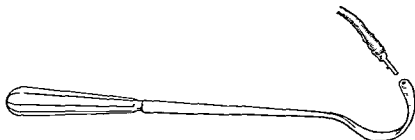


Fig. 1137.—TRENDLENBURG'S SOUND. WHEN THE PERICARDIUM HAS BEEN INCISED THIS INSTRUMENT IS PASSED THROUGH THE TRANSVERSE SINUS. A SLOT-AND-STUD LATCH AT THE END ALLOWS A PIECE OF RUBBER TUBING TO BE ATTACHED AND DRAWN ROUND THE TWO GREAT ARTERIES. AN ELASTIC TOURNIQUET RETRACTOR IS THUS PROVIDED.

- (6) Incision into the pulmonary artery need not be longer than 1 inch. The ends of the incision should be controlled by tissue forceps or stitches in case the vessel slips back from the clamp into pericardium after circulation has been restored.
- (7) Several attempts with forceps or a powerful sucker may be necessary to extract the clot.
- (8) Adrenalin 1 cc. should be injected into the base of the aorta as soon as the clot is removed. This affords the most effective way of stimulating the coronary circulation. Injection into the right ventricle is also practised.

The chances of performing the operation are naturally limited, but if the necessary instruments are always kept ready for use, as is the common practice with tracheotomy and infusion sets, a suitable occasion will sooner or later arise.

CHAPTER VI

INTRA-THORACIC TUMOURS

TUMOURS within the thoracic cage may attain considerable dimensions before their presence is suspected. *Per contra* it is not unusual for a comparatively small growth to give rise to early distress. It depends on their situation. The lung fields are comparatively "silent," but small increases of pressure within the mediastinum give early warning. The limit of expansion is governed by the rigidity of the thorax, and the rapidity of symptom-onset depends on the ability of the compressed organs to adapt their functions to increased pressure.

Tumours are classified according to their behaviour, as benign or malignant. The surgical possibilities of relief in the malignant types are small, particularly as the most common thoracic neoplasm is multiple secondary carcinoma. There are, however, some cases of primary pulmonary cancer which can be extirpated successfully. *Benign growths offer a better chance of cure, especially when they are excised at an early stage before signs become too apparent.*

A pathological classification of the more common forms of neoplasm and conditions which are loosely grouped under the heading of "tumours" follows :

BENIGN.

Chest Wall.

Chondroma of rib.

Endothelioma of pleura.

Mediastinum.

Dermoid cyst.

Ganglio-neuroma.

Fibroma.

Neurinoma.

Thymoma.

Parathyroid adenoma.

Lipoma.

Lungs.

Bronchial fibroma.

Retro-sternal Goitre.

Aneurysm.

Congenital cyst.

Hydatid cyst.

APPROACHES TO UPPER MEDIASTINUM

(1) Milton's operation—sternum splitting.

Incision: T-shaped with the vertical arm along the middle of the sternum carried down to bone 1-2 inches below the manubrium. The supra-sternal notch is cleared and a finger passed into the loose cellular tissue behind the manubrium. A special Lebsche chisel or Schumacher's shear is used to divide the sternum as far as the 2nd or 3rd interspace. At the lowest point the division is carried out on either side through the

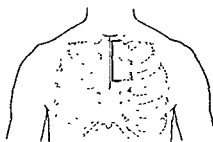


Fig. 1138.—MILTON'S STERNUM SPLITTING APPROACH TO MEDIASTINUM. FINE LINE INDICATES SKIN INCISION. HEAVIER LINE REPRESENTS APPROXIMATE BONE SECTION.

sternum into an interspace. A powerful retractor separates the divided bone. The thin margins of the pleural sacs as they approximate the mid-line are very easily injured—and if either is torn the anaesthesia must be controlled and administered by over-pressure methods. The presence of thin-walled great veins will be recognised and their collapse and filling with respiratory movements should be borne in mind while the tumour is being enucleated. Closure of the wound can be effected by an encircling suture round the sternum or through specially drilled holes. Sometimes suture of the overlying tissues is sufficient to keep the bone edges approximated.

(2) Upper Transpleural.

Incision: [] shaped along the line of the 2nd rib down the border of the sternum and outwards along the 4th or 5th rib. The incision is deepened down to rib level. Two alternatives are possible:

(i) Formation of an osteoplastic flap. The costal cartilages are divided close to the sternum, the pleura is incised, and the whole flap reflected outwards carrying on it the pectoral muscles and breast.

MALIGNANT—PRIMARY.

Chest Wall.

Sarcoma.

Endothelioma.

Mediastinum.

Teratoma.

Lympho-sarcoma.

Lymphadenoma.

Lungs.

Carcinoma.

Central hilar.

Peripheral lobar. }

{	Adeno-carcinoma,
	Squamous-celled, metaplasia,
	Undifferentiated, so-called "oat-celled."

Sarcoma.

MALIGNANT—SECONDARY.

Chest Wall.

From mammary cancer.

Mediastinum.

From breast, etc.

Lungs.

Sarcoma.

Carcinoma.

There is no set operation for removal of any given tumour. Certain methods of exposure of the interior of the chest are commonly practised and these will be described, though it is obvious that liberal modifications must be made to meet varying conditions.

The principles that govern intra-thoracic operations for removal of tumours include free exposure, routine use of positive pressure anæsthesia, careful separation of tumour from adherent structures (viz.: lung, pericardium, thin-walled veins), re-expansion of lung, accurate closure of the chest and preparations against shock. The presence of infection and compensation for a large dead space are other factors that may have to be reckoned with. Excision of large tumours at one session is often impossible, and though subsequent operations are invariably complicated by the formation of granulation tissue, the risks of shock are minimised.

APPROACHES TO UPPER MEDIASTINUM

(1) Milton's operation—sternum splitting.

Incision : T-shaped with the vertical arm along the middle of the sternum carried down to bone 1-2 inches below the manubrium. The supra-sternal notch is cleared and a finger passed into the loose cellular tissue behind the manubrium. A special Lebsche chisel or Schumacher's shear is used to divide the sternum as far as the 2nd or 3rd interspace. At the lowest point the division is carried out on either side through the

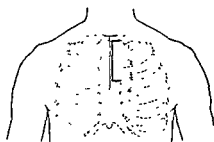



Fig. 1138.—MILTON'S STERNUM SPLITTING APPROACH TO MEDIASTINUM. FINE LINE INDICATES SKIN INCISION. HEAVIER LINE REPRESENTS APPROXIMATE BONE SECTION.

sternum into an interspace. A powerful retractor separates the divided bone. The thin margins of the pleural sacs as they approximate the mid-line are very easily injured—and if either is torn the anæsthesia must be controlled and administered by over-pressure methods. The presence of thin-walled great veins will be recognised and their collapse and filling with respiratory movements should be borne in mind while the tumour is being enucleated. Closure of the wound can be effected by an encircling suture round the sternum or through specially drilled holes. Sometimes suture of the overlying tissues is sufficient to keep the bone edges approximated.

(2) Upper Transpleural.

Incision :  shaped along the line of the 2nd rib down the border of the sternum and outwards along the 4th or 5th rib. The incision is deepened down to rib level. Two alternatives are possible :

(i) Formation of an osteoplastic flap. The costal cartilages are divided close to the sternum, the pleura is incised, and the whole flap reflected outwards carrying on it the pectoral muscles and breast.

Division of ribs at the outer part of the flap allows the hinge to be more effective.

(ii) **Excision of underlying ribs.** The ribs appearing in the incision are resected subperiosteally, and the pectorals and breast retracted laterally; a flap of posterior periosteum, intercostals and pleura is made for entry into the chest. This course is advisable if the ribs are rigid and do not bend back easily.

If the mediastinum is to be reached from this opening the thin mediastinal pleura has to be incised. Careful suture in layers after re-expansion of lung is imperative.

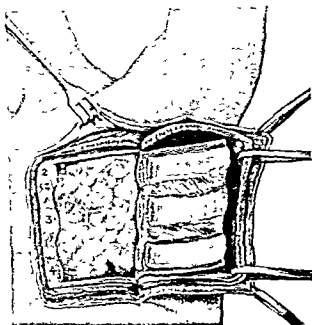


Fig 1139.—OSTEOPLASTIC FLAP FOR EXPOSURE OF THE ANTERO-LATERAL THORAX. RIBS 2, 3 AND 4 ARE DIVIDED CLOSE TO THE STERNUM AND AGAIN AT THE LATERAL LIMIT OF EXPOSURE, SO THAT THEY CAN BE TURNED OUTWARDS ON A HINGE WITH THE COVERING PECTORAL MUSCLES. THE LONG SURFACE IS SHOWN WITH THE INTERNAL MAMMARY ARTERY LOCATED AT THE UPPER AND LOWER LIMITS OF THE WOUND. THE RIBS IN THE FLAP CAN BE EXCISED IF NECESSARY, BUT THIS INVOLVES STRIPPING MUSCLE FROM THEIR SURFACE WHEREAS IF TURNED BACK IN THE FLAP THEIR LATERAL DIVISION CAN BE MADE FROM INSIDE.

APPROACHES TO THE PLEURAL CAVITY

(1) Anterior or Submammary.

Incision: Transverse 8-10 inches along the line of the 4th-5th interspace. Entry to the pleural cavity can be obtained by intercostal incision. Rib resection is only necessary if the bone is not elastic.

Exposure is obtained by separating the ribs with a powerful rib spreader.. This is a lower approach than the one described above for the mediastinum.

(2) Lateral.

Incision : Along the line of ribs 5, 6 or 7. The obliquity of the ribs in this situation is not always realised. Intercostal incision will usually suffice, though removal of lengths of as many ribs as is thought necessary may be practised. If more than one rib is to be resected the incision should be slightly curved.

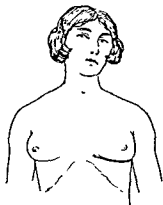


Fig. 1140.—SUBMAMMARY INCISION FOR EXPOSURE OF THE ANTERIOR PART OF THE LOWER THORAX. OFTEN SUITABLE FOR APPROACH TO MEDIASTINAL DERMoids WHICH EXPAND INTO THE LUNG FIELD FROM THE MEDIASTINUM.

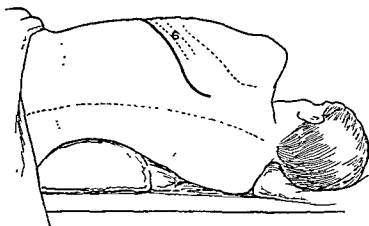


Fig. 1141.—INCISION FOR POSTERO LATERAL THORACOTOMY. PATIENT LYING ON SIDE WITH RIBS WELL ARCHED—THE PILLOW UNDER THE PLANE SHOULD BE HIGHER IN THE AXILLA. THE OBLIQUITY OF THE INCISION ALONG THE LINE OF THE RIBS SHOULD BE NOTED. A SLIGHT VERTICAL PROLONGATION AT THE POSTERIOR LIMIT OF THE INCISION ALLOWS FOR DIVISION OF RIBS WHICH CAN THEN BE "SHINGLED" BY RETRACTION.

(3) Posterior.

Incision : Starting in the paravertebral region, carried almost vertically downwards for an inch or so, thence along the line of the intercostal space (7th) selected. Muscles incised to rib level and all bleeding points secured. Intercostal incision 8 or 9 inches long may suffice if powerful retraction is used, but resection of rib is permissible. Shingling of ribs above the incision allows a very satisfactory exposure ; this is done by dividing one or more ribs close to the spine and retracting so that the ribs freed from their attachment tend to lie over each other.

Closure is effected with pericostal sutures to hold the separated ribs together, and suture of the intercostal muscles. The lung is fully expanded and superficial muscles are sewn up to render the wound air-

tight before suturing the skin. A small intercostal closed drain may be inserted through a separate stab incision before the chest is closed, or any effusion that collects can be aspirated as occasion demands.

TUMOURS

Tumours, suitable for intervention, most commonly encountered in the thorax are: Retro-sternal goitre, mediastinal dermoids, hydatid cysts and primary carcinoma.

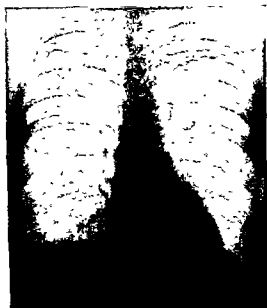


Fig 1142.—RETRO STERNAL GOITRE. A rounded shadow is present in the upper mediastinum extending more into the field of the right apex than the left. It reaches down to the arch of the aorta. The patient was suffering from definite pressure symptoms. The tumour was removed through the ordinary neck collar incision without having to split the sternum.

Retro-sternal goitre may take the form of a "plunging" goitre or remain in the thorax where its calcification is common. Respiratory distress is usual, and radiologically a round bordered shadow is seen in the anterior mediastinum. Removal of the goitre through the usual neck approach is often possible, but great care must be taken to secure the lower pole blood-vessels. With an impacted tumour a vertical sternal split allows a more satisfactory approach.

Mediastinal dermoids arise from the anterior mediastinum and tend to spread into either lung field when the increase in size may not

attract attention for some time. The majority of cases are seen in early adult life, though successful operation at the age of 3 years has been undertaken. The symptoms in order of importance are dyspnoea, cough and pain. A fortunate diagnosis may be made from the sputum if sebaceous matter, hair or cholesterol crystals are found therein. Hæmoptysis is fairly common.

Rapid enlargement and infection are frequent complications. Fistula formation into the air tubes from and on to skin (as result of incision following mistaken diagnosis) are both seen. The patient is usually subject to intermittent pulmonary infections. X-ray generally shows a circumscribed shadow.

Without infection one-stage excision of cysts of moderate size is practicable, but if the tumour attains the size of a foetal head, evacuation of the contents and most of the cyst wall at a preliminary stage may have to be followed by operation for removal of the cyst wall left behind. Infected cysts require a preliminary operation for drainage before the wall can be completely excised. Adherence to pericardium and great vessels as well as to lung and pleura constitutes one of the principal difficulties of the operation.

Primary lung carcinoma is only suitable for operation in a limited proportion of cases. Occasionally a growth may be recognised early when it obstructs a bronchus, atelectasis or bronchiectasis resulting according to the type of the obstruction. Growths near the periphery may produce early blood-stained effusion or empyema, and marked central necrosis gives rise to abscess formation. Slight pyrexia with weakness and breathlessness for which no apparent cause can be found is a suspicious symptom-complex which demands careful investigation of the lungs. Radiology supplemented by lipiodol injection may show a "rat-tailed" type of stenosis. Bronchoscopy is invaluable for visualising the intra-bronchial condition and estimating the induration of a suspected area; it also provides material for biopsy.

The hilar forms are often precluded from operative intervention by the position of the growth and secondary deposits, but exploration is fully justified in doubtful cases. Lobectomy is the standard procedure for excision, and the line of section must be as close to the mediastinum as possible. Lobectomy for the peripheral types of growth is more satisfactory so long as the disease does not extend beyond the lobe excised.

The value of deep X-ray therapy and radium is problematic. Radium or radon can be applied through a bronchoscope, but on the

whole the results of intra-bronchial application are disappointing. Local excision of circumscribed small tumours through the bronchoscope has occasionally been successful.



Fig 1143.—BRONCHIAL CARCINOMA PRODUCING STENOSIS AND BRONCHIECTASIS. LIPIODOL X RAY OF THE BASE OF THE LEFT LUNG. THE STENOSIS IS INDICATED BY THE ARROW BELOW WHICH DILATATIONS ARE VISIBLE. IN ACTUALITY THE BRONCHIECTATIC AREA WAS MUCH MORE EXTENSIVE THAN INDICATED IN THIS PICTURE. EXPLORATORY THORACOTOMY WAS PERFORMED BUT THE GROWTH WAS FOUND TO HAVE INVADDED THE MEDIASTINUM AT ONE POINT AND WAS THEREFORE INOPERABLE.

Hydatid cysts can roughly be grouped as central and superficial. The capsule is unduly thin and expansion of the cyst rapid. The central forms either rupture into the air tubes spontaneously or can be compressed until this occurs, while peripheral cysts demand more active measures. In this case by operating as for abscess the cyst wall can be removed after the pleura has been shut off. Exploratory aspiration is contra-indicated on account of the risk of dissemination.

CHAPTER VII

BRONCHIECTASIS

No branch of thoracic surgery has attracted recent attention more than the treatment of bronchiectasis. Physicians and surgeons alike have come to the conclusion that conservative measures can never cure the well-established disease, and that more active treatment must be employed to eradicate a condition in which fœtor, cough and toxæmia render the victim's life almost unbearable. The recognition of bronchiectasis in its early stages, before these distressing symptoms appear, is becoming more and more frequent from the association of lipiodol with radiography, and this, combined with the improved technique of operation procedures, yields great hope of relief in the near future.

Two forms of bronchiectasis are described :

- (1) The acquired adult form.
- (2) The congenital cystic form commonly seen in children.

(1) The ætiology of *acquired bronchiectasis* includes numerous factors whose relative importance has not yet been conclusively determined. *Bronchial walls, weakened by inflammation, are stretched by the increased intra-bronchial pressure induced by prolonged and severe bouts of coughing. Infective matter collects in the dilated tubes and produces further destruction of their walls, so that eventually a cavity is formed which can only be emptied by overflow, and it is doubtful if the pus at the bottom of these dilatations is ever completely evacuated. Secondary fibrotic and inflammatory changes occur in the surrounding parenchyma, and collapse of the cavities is further hindered by increased rigidity.*

Several forms of acquired bronchiectasis are recognised according to their pathological variations :

- (a) Atrophic, in which the bronchi are dilated over most of their length ; the cylindrical type.
- (b) Fibrosis and induration of distended bronchial walls.

- (c) Irregular cavitation with progressive ulceration ; the saccular type.

The predisposing clinical causes of any of these forms include any condition which leads to lung damage and fibrosis. The chest complications that follow measles and whooping cough are the very common offenders. The drag on and distortion of bronchi of all sizes in cases of pulmonary abscess and tuberculosis of long standing strongly predispose to bronchiectatic changes. Bronchial obstruction is perhaps the most frequent cause. External pressure from gland enlargements and so forth is less common than obstruction from within. Septic material—blood, pieces of tonsils, teeth, etc.—may be impacted in an air tube and coughing fail to expel it. If the bronchus is completely occluded atelectasis is bound to follow, but in most cases a valve-like action results and infection plus increased pressure lays the train for bronchiectasis in the tube beyond.

(2) *Congenital bronchiectasis*, with which may be allied cystic disease of the lung, is fortunately less distressing at the outset than the acquired form, especially as it gives rise to symptoms in younger life. One or more large cysts, sometimes simulating pneumothorax cavities, can be seen in X-ray films. The multiple dilatations seen in "honey-comb" lung are another form. Intra-uterine and developmental accidents have been suggested as causes, while rupture of pulmonary tissue, following convulsive thoracic movements of a partially asphyxiated foetus, may be a predisposing factor. Arrest in the development of the bronchial tree may produce sacs at the end of a large bronchus instead of the final normal ramifications. Alternatively, large bronchi may become shut off leaving potential cystic spaces distal to the occlusion.

Symptomatology and Diagnosis. Bronchiectasis is a condition confined principally to the lower lobes of the lungs, and although only one side is affected at first bilateral development is inevitable as the disease progresses. The patient's appearance shows the results of respiratory obstruction and anoxæmia when the disease is well established, general cyanosis and clubbing of the fingers being especially noticeable. Cough is very distressing from the length of the bouts, and may positively wear the patient out until some means of assisting evacuation of the cavities (e.g. by postural drainage) is instituted. The daily bulk of sputum is enormous, often as much as 15 to 30 ozs. ; its pus separates

out into the familiar three layers and its stench makes it almost impossible for anyone to live with the patient. *Hæmoptysis* is frequent and indicates active ulceration. A dry form, in which sputum is absent, may only attract attention by bleeding. The physical signs vary with the size and fluid content of the cavities; dullness is the rule, and breath sounds are anything from amphoric to faint bronchial in character. Displacement of the mediastinum with scoliosis is seen in bad cases. Congenital forms are comparatively free from symptoms apart from a liability to recurrent coughs and colds, until the spaces become infected, when the condition rapidly approaches the acquired form in its objectionable features.

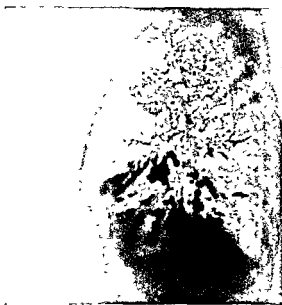
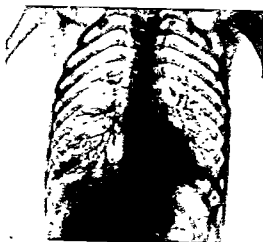


Fig. 1144.—LATERAL VIEW OF A WELL-ESTABLISHED
SACULAR BRONCHIECTASIS.

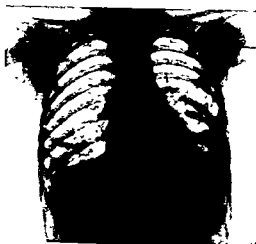
Without the injection of a contrast fluid, a radiogram is not conclusive. Thickening of hilar shadows and increased striation towards the bases are the most obvious features, though in some cases the outline of bronchial walls can be seen as rings or parallel lines which do not taper off towards the periphery. Occasionally fluid levels are visible. After injection of lipiodol the radiological picture shows clear-cut outlines to the bronchial lumina and pools of the oil in terminal dilatations throw dense shadows. These shadows are not always obvious at first sight, if they lie below the level of the diaphragm, but in a good film small glove-like fingers or "blobs" are quite clear and fluid levels can be seen. The terms saccular and cylindrical define the appearance of the more common forms of bronchiectasis.

Treatment. The dilated basal cavities are veritable culture-tubes for organisms and their drainage constitutes the first problem in treatment. Postural drainage should be practised as a routine and prepares the patient for operation by reducing the degree of toxæmia, but it is doubtful if cavities are ever completely emptied by these means.

The most simple way of performing postural drainage is to make the patient lean over the side of the bed so that gravity can assist emptying of the air tubes. The majority of patients support themselves by



(1) PROBABLY OF CONGENITAL ORIGIN. DILATED BRONCHI FILLED WITH LIPIODOL LIE WITHIN THE HEART SHADOW ON THE LEFT. TOXICITY WAS EVIDENCED BY CYANOSIS AND CLUBBING OF FINGERS. THERE WAS SOME PURULENT SPUTUM.



(2) X RAY TAKEN 12 DAYS AFTER SINGLE STAGE LOBECTOMY SHOWS ALMOST COMPLETE FILLING OF THE CHEST BY THE UPPER LOBE. THE DIAPHRAGM IS RAISED AS A RESULT OF PHRENIC CRUSHING AT OPERATION. CONVALESCENCE UNSATISFACTORY. CLUBBING OF FINGERS DISAPPEARED WITHIN SIX WEEKS.

resting their hands on the floor or a low stool and soon become accustomed to the facial congestion that the position entails. As pus reaches healthy bronchial mucosa the cough reflex is elicited and quantities of pus are ejected and the patient can depend on freedom from cough for some hours, when postural drainage can again be instituted. It is customary to empty the cavities on waking and before going to sleep at night, and in addition as many times as is required by day.

Spirochaetal organisms in the pus are said by some to account for the foetor, and even with a negative Wassermann reaction N.A.B. or some other arsenic compound should be administered. Vaccines, creosote, vapour baths, etc., only give temporary relief of symptoms, but with all these alleviative measures no permanent improvement can be looked for unless the bronchi are completely drained of their secretions.

Improvement does occur by natural remissions of the disease when conservative treatment is employed, but nothing in the nature of real cure can be expected while the patency of the cavities remains a lasting source of danger. The relief afforded by collapse therapy is only temporary ; it fails to maintain satisfactory compression of the dilated bronchi. It has been truly said that " a cure can only be considered when the diseased portion of the lung has been removed or destroyed " (Graham), so that the tendency of treatment must be to aim more and more at excision of the disease areas.

At the present time surgery is only concerned with treatment of unilateral cases affecting one lobe, though there are reasonable hopes that bilateral cases will eventually be eligible for operation. Bilateral basal lobectomy has been successfully performed. Before deciding upon operative treatment the degree of toxæmia must be taken into account and reduced as far as possible. Preliminary investigation of the oro-pharynx is most important, the tonsils and accessory nasal sinuses in particular being held responsible for the maintenance of bronchial infection.

Operative treatment may be considered under three headings :

- (1) Bronchoscopic drainage.
- (2) Collapse therapy.
- (3) Excision of the diseased lobe (*lobectomy*) with or without drainage of the cavities.

Bronchoscopy is a valuable initial measure of treatment. Foreign bodies are recognised and removed, and it is remarkable how often a foreign body is found when its presence has not even been suspected. Aspiration of thick secretions is possible, and considerable improvement undoubtedly accrues from the regular practice of endoscopic aspiration, but on the other hand it is doubtful if obliteration of, or restoration to, the original calibre of the dilated bronchi is ever obtained.

Collapse therapy has had an extensive trial in the treatment of bronchiectasis, but the results do not indicate that it is a means of cure. In rare cases artificial pneumothorax has obtained collapse and healing of thin-walled cavities ; phrenicectomy has also had some good temporary effects on basal lesions, but beyond altering the angulation of the bronchi, thus helping drainage and diminishing cough, the final results have been disappointing. Extensive para-vertebral thoracoplasty does definitely help, even cure some cases, but

here again the dilated bronchi may not be completely obliterated. The operation, even when performed in stages, is severe and not free from the danger of cerebral abscess due to the compression of pus.

Drainage of the infected lung by exposing the affected lobe and incising the purulent areas reduces toxæmia, but is only possible where

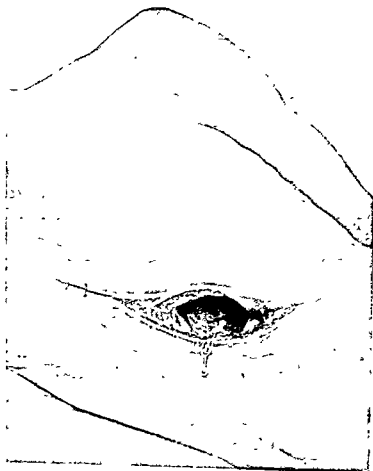
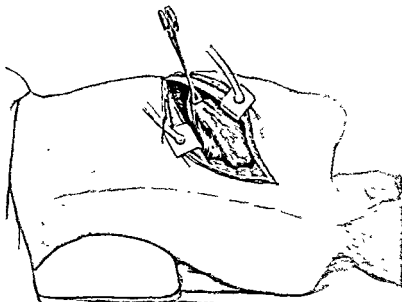


Fig. 1145.—DRAINAGE OF BRONCHIECTATIC CAVITIES FOLLOWING TRANSVERSE AMPUTATION THROUGH THE LOWER LOBE. LARGE WOUND IN THE PROCESS OF HEALING. CASE OF BRONCHIECTASIS WITH ABSCESS FORMATION, COUGHING UP EXTREMELY FETID SPUTUM IN LARGE QUANTITIES. THE ADHERENT LOWER LOBE EXPOSED AND CUT ACROSS WITH CAUTERY TO EXPOSE AS MANY OF THE MAIN BRONCHI AS POSSIBLE. BLEEDING NOT EXCESSIVE AND EASILY ARRESTED. A BRONCHIAL FISTULA PERSISTED.

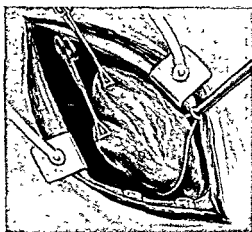
a few large bronchiectatic cavities are present. Transverse amputation through the lower lobe should lay open all the larger bronchi and allow them to drain thoroughly. Bronchial fistulæ will remain, but the question of their closure need not arise for several years. An amplification of this type of drainage is found in Graham's cautery pneumonectomy, in which the lung is gradually destroyed while drainage progresses.

Lobectomy is the operation of choice in unilateral bronchiectasis. The operation is one of considerable severity, but with improving technique and careful pre-operative treatment will yield better and better results as time goes on.

The chief problems of any form of lobectomy are: (i) to prevent infection of the pleural cavity, (ii) to limit the risk of mediastinal



A. THE THORAX OPEN, RIBS WIDELY SEPARATED WITH RETRACTORS, AND THE LUNG HELD UP IN DUVAL FORCEPS. AN INTERCOSTAL INCISION HAS BEEN MADE AND A SHORT LENGTH OF RIB EITHER SIDE OF THE INCISION RESECTED TO ALLOW BETTER EXPOSURE. NOTE ADHESIONS POSTERIORLY TOWARDS THE DIAPHRAGM.



B. THE LOBE HAS BEEN FREED FROM ADHESIONS AS FAR DOWN AS THE HILUM AND A SNARE HAS BEEN PASSED OVER THE LOBE TO BE GUIDED TO THE STUMP OF THE LOBE. IT IS NOT POSSIBLE TO CONVEY THE IDEA OF DEPTH IF LIGHTING IS TO BE ADEQUATE TO SHOW UP DETAILS WITHIN THE THORAX.

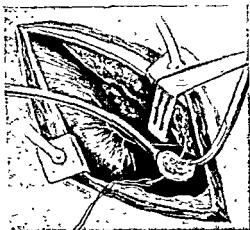


LOBECTOMY CLAMP.
(ROMANS SELLORS.)

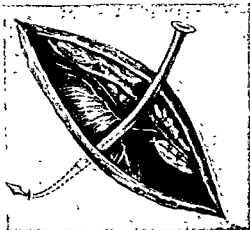
C. POWERFUL CLAMP USED FOR SECURING THE HILUM AND ENSURING REMOVAL OF THE LOBE AS CLOSE TO THE MEDIASTINUM AS POSSIBLE.

emphysema and suppuration, (iii) to avoid leakage from the stump. Technically the simplest form is a single-stage operation in which the chest is opened and the affected lobe freed and amputated at the hilum; but fear of the above complications has led many to prefer the delayed or multiple-staged lobectomy. Improvements in the technique of the one-stage operation have recently increased its popularity.

Single-stage or Immediate Lobectomy. Preliminary pneumothorax may be employed to give some idea of the degree of pleural adhesions and to reduce shock when the chest is opened, but it is not essential.



D. THE LOBE HAS BEEN REMOVED. THE TUBE OF THE SNARE LIES CLOSE AGAINST THE BARE STUMP IN WHICH VESSELS AND BRONCHI ARE VISIBLE. CURVED FORCEPS ARE PLACED DISTAL TO THE SNARE TO PREVENT SLIPPING, AND A TRANSFIXION SUTURE IS BEING PASSED THROUGH THE STUMP TO SECURE BLOOD-VESSELS AND AIR TUBES. IN THE UPPER PART OF THE WOUND THE UPPER LOBE IS HELD BACK WITH A RETRACTOR OR PACKED OFF WITH SWABS. IN THE LOWER PART OF THE WOUND THE DIAPHRAGM IS APPARENT WITH THE BRANCHES OF THE PHRENIC NERVE SPREADING OVER IT. THE MAIN PHRENIC TRUNK CAN BE CRUSHED AT AN EARLIER STAGE IF REQUIRED.



E. THE STUMP VESSELS HAVE ALL BEEN SECURED AND THE SNARE (OR RUBBER TUBING) REMOVED. ANY FREE LUNG TISSUE HAS BEEN SUTURED OVER BRONCHI AND VESSELS AND THE STUMP APPROXIMATED TO THE UPPER LOBE. IT IS RARELY POSSIBLE TO EFFECT GOOD MECHANICAL CLOSURE OF THE STUMP BY OVERSEWING IF THE LINE OF REMOVAL IS KEPT REALLY CLOSE TO THE HILUM OF THE LUNG. A SMALL FLANGED TUBE IS BEING PASSED THROUGH AN INTERCOSTAL SPACE AT THE BASE OF THE PLEURAL CAVITY ON A SPECIAL CURVED CUTTING INTRODUCER. THE WOUND IS THEN CLOSED AND THE DRAIN CONNECTED WITH SOME CLOSED SYSTEM.



Drainage-tube introducer.

F. THE RUBBER TUBE IS TIED OVER THE SERRATED BLUNT END AND IS CARRIED INTO POSITION BY PUSHING THE TRIANGULAR BLADED KNIFE THROUGH SOFT TISSUES. THE STAR WOUND THAT'S MADE IS AIR-TIGHT ROUND THE TUBE.

Anæsthesia : Preliminary basal narcosis supplemented by over-pressure inhalation anæsthesia.

The patient is placed on the sound side with a firm pillow under the axilla to arch the side of the operation. A slight downward inclination of the head allows secretions to flow towards the pharynx from which they can be removed by a suction tube.

A long incision is made along the line of the 6th or 7th interspace, and deepened through muscle to rib level. Several bleeding points will require ligature. The chest is opened for 8 to 10 inches by deepening the incision in the exposed interspace. As the pleura is being incised the anæsthetist allows the lung to collapse slowly and must be ready to prevent mediastinal flutter or any other untoward symptom by raising the intra-alveolar pressure. Separation of the ribs by de Quervain's or other powerful retractors usually allows sufficient exposure, but excision of a short length of one or more ribs at the posterior end of the incision may assist in giving more room.

The affected lobe is inspected and any adhesions divided with scissors over the parietal and basal aspects. The adhesions are usually fine and easily separated, though in long-standing cases their deliberate division may be necessary. Bleeding from the cut edges is negligible.

Separation along the interlobar fissure is carefully effected, and on the mediastinal aspect the pulmonary ligament is divided from below to the hilum. A vessel in this ligament generally requires ligature. If respirations are unduly turbulent or if the lobe is large, the phrenic nerve as it lies on the pericardium should be crushed.

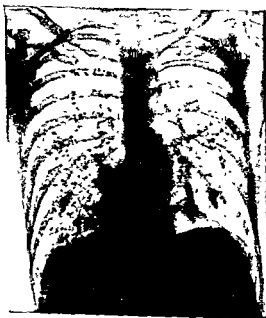
The lobe is thus free over its whole surface except for its attachment close to the mediastinum. A piece of rubber tubing or snare is tightened round the hilum, or a crushing clamp is used, to occlude the lobar blood-vessels. The lung is then amputated by a hollow cone or wedge incision so that margins of the lung tissue can be brought together over the stump. Several mattress sutures are run through the stump to secure the vessels, and after excising and crushing protruding ends of bronchi a stitch is run through the cuff of lung tissue to bring the raw edges together. A final additional suture or so should bring visceral pleural surfaces into good apposition. The snare is removed and the stump inspected for bleeding; the pressure in the bronchial system is increased by the anæsthetist to see that the stump is air-tight and dry. Securing the stump to the under-surface of the upper lobe adds to its fixation. For a more complete removal of the lobe a heavy crushing clamp should be applied as close to the mediastinum as possible and ligatures tied deep to this. Where a snare or tourniquet

is used a certain amount of the lobe must be left behind for sewing over the hilum.

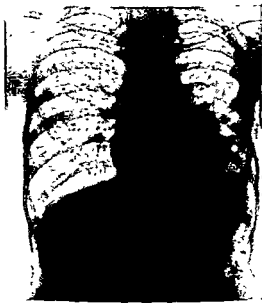
A stab wound is made in the lowest part of the chest and a small intercostal tube inserted and clipped. The ribs are approximated by pericostal sutures and the pleuro-intercostal layer thus brought together. While closure is in progress the anaesthetist raises the pressure until complete expansion of the lung is obtained as the pleural opening is closed.

Superficial muscles are brought together with a running stitch reinforced by a few interrupted sutures, and after ascertaining that there is no leak into the chest the skin is sutured without drainage. A light dressing is covered with strapping, and on return to bed the intercostal tube is connected to a suction apparatus.

The degree of shock varies, but infusions and blood-transfusions should be ready in every case. As a rule some effusion into the pleural sac follows, and this occasionally becomes infected, but usually clears up with the help of the drainage-tube inserted at operation. Sometimes a chronic empyema develops and requires treatment. Tension pneumothorax is occasionally an early complication, only occurring if the drainage-tube becomes blocked.



A.



B.

Fig. 1148.

A. LIPIODOL INJECTION AFTER BRONCHOSCOPIC ASPIRATION. CHILD AGED 10 YEARS, TOXIC SYMPTOMS OF BRONCHIECTASIS BECOMING MARKED. X RAY SHOWS NORMAL RIGHT BRONCHIAL TREE AND SACULAR BRONCHIECTASIS OF THE LEFT LOWER LOBE. LOBECTOMY IN ONE STAGE FOLLOWED BY CLOSED DRAINAGE. B. X RAY SIX WEEKS LATER SHOWING PARTIAL RE-EXPANSION OF UPPER LOBE AND ELEVATION OF DIAPHRAGM FOLLOWING CRUSHING OF THE PHRENIC NERVE AT OPERATION.

The dead space left at operation usually fills, compensatory emphysema and elevation of the diaphragm both playing a large part, but persistence of a clean dead space of large size is not incompatible with good health.

Delayed or Multiple-stage Lobectomy. The fear of empyema and other complications that may occur in the single-stage operation has led to the practice of lobectomy after the greater part of the pleural cavity has been shut off by adhesions. The single-stage depends largely for its security on healing and non-leakage of the main bronchus and stump. In the several-stage procedure the first endeavours are to isolate the affected lobe by formation of granulation tissue and then at a later date to remove the lobe in bulk or piecemeal.

Three types of delayed lobectomy can be described :

(1) Following "Plombierung" or "Plombage."

This method as employed by Sauerbruch and other continental surgeons consists of making an incision along the length of the interlobar fissure and without injury to the parietal pleura of making a space into which paraffin wax is wedged. This "Plombe" is placed over the full length of the septum and exerts pressure on the underlying visceral pleura leading to the formation of adhesions. At the same time this operation appears to have the effect of stabilising the mediastinum.

Following an interval of 2 to 3 weeks the "Plombe" is removed and lengths of ribs 5 to 7 or 8 are excised to allow free exposure of the bronchiectatic lobe. The interlobar fissure is located by blunt dissection among the artificially formed adhesions and the lobe separated down to the hilum. A piece of rubber tubing, to constitute a firm ligature round the main bronchus and vessels, is applied, and in the course of 7 to 17 days natural separation of the lobe occurs. To prevent erosion into the vessels it is sometimes advisable to tie the ligature loosely at first and to tighten it gradually at intervals.

The space that is left fills in rapidly by granulation, but occasionally a residual bronchial fistula requires closure. Infection of the space is an unimportant factor as the pleural cavity is shut off and free drainage is established.

(2) Following adhesions produced by mechanical irritation of the pleura.

Methods aiming at obtaining satisfactory adhesions have not been entirely successful. The operation devised by John Alexander over-

comes some of the difficulties by inducing traumatic inflammation of the pleural surfaces.

The chest is freely opened under positive pressure anæsthesia by excision of ribs 6, 7 and 8, and the interior of the parietal pleura is stroked with gauze over its whole surface. The wound is closed with the lung in full expansion. The resulting inflammation produces adhesions and some exudate. This latter should be removed by aspiration if it attains any bulk.

Ten days later the chest is opened again and the adhesions round the affected lobe are separated by blunt dissection. The hilum is transfixed with stout silk ligatures and the lobe in due course sloughs away. It may be necessary to divide the cartilaginous bronchus with scissors to complete the separation.

(3) By cautery pneumonectomy.

This multiple-stage operation carried out in selected cases with considerable success by Graham consists of isolating the lobe and rendering it adherent and then destroying lung tissue by successive applications of the cautery.

At the first stage a free posterior thoracotomy is performed by excision of lengths of 2 to 3 ribs. Adhesions are produced by packing against the pleura or by suture and the wound partly closed.

After an interval of 10 days the now adherent lobe has decreased in size and the exposed surface is cauterised with a soldering iron at dull red heat. Bleeding is controlled by firm packing, which is not disturbed for some days.

Three weeks later further bronchi are opened with cautery and drainage is well established at the same time as the lobe is being destroyed. Further applications of cautery complete the lobectomy. Bronchial fistulæ may result, but the inconvenience of these is minimal.

The advantage of this form of operation lies in the fact that efficient drainage of the dilated bronchi can be established in gravely ill patients without having recourse to the more serious operation of removing the lobe *in toto*. Then at a later date, if the condition of the patient improves, more effective amputation or destruction of the lobe can be considered. A disadvantage of the operation is the prolonged period that is required for treatment.

Similar types of operation have been practised successfully using bunch ligatures on the isolated lobe instead of cautery. The principle underlying the delayed form of operation depends, as has already been

said, on the pleural space being non-adherent, but it should be noted that if adhesions are present in sufficient quantity at the original operation the actual measures for removing the lobe can be proceeded with straightway.

ACKNOWLEDGMENT

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T. H. S.

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by
J. LYLE CAMERON

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SECTION 1
REGIONAL GYNÆCOLOGY

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CHAPTER I
GYNÆCOLOGICAL INVESTIGATIONS

GYNÆCOLOGICAL investigations fall into two groups :

- (A) History of the case.
- (B) Physical examination of the patient.

HISTORY OF THE CASE

The taking of an accurate and detailed history is the first step in the investigation of a gynæcological case. A certain routine should be followed, and the more simplified this is, the better. Inquiry should be made as to :

(1) *Age, occupation*, and whether the patient is *single or married*, etc.

(2) *Pregnancies* : number of children, date of the last confinement, complications of labour or the puerperium ; *miscarriages* : number, date of the last, and complications if any.

(3) *Menstrual history* : age at onset, cycle, duration of period, amount lost ; the passage of clots, their character and their relation to the menstrual flow ; date of the last regular menstrual period ; change in loss, i.e. increase or decrease in amount, or alteration of rhythm ; intermenstrual bleeding, even trivial.

(4) *Vaginal discharge* : character and colour ; when first noticed.

(5) *Pain*: this is the most common and one of the most important of gynæcological symptoms. Its character should be noted, i.e. whether continuous or intermittent, time when first felt, exact site, radiation, and relation to the menstrual period, micturition, defæcation or coitus.

(6) *Hæmorrhage* is also a common and important symptom, and its origin, character, amount, and relationship to the menstrual period should be noted.

The site of origin of the bleeding is determined by the routine method of examination, as described later on in this chapter. Bleeding may occur from the vulva, urethra, vagina, cervix or body of the uterus.

The loss may be a thin serous discharge such as frequently comes from a cancer of the cervix or body of the uterus; a brownish discharge such as occurs in ectopic gestation; dark-coloured non-coagulable fluid such as the normal menstrual flow; or bright red and associated with clots, signifying true hæmorrhage.

Hæmorrhage may vary from very slight loss to a profuse outpouring sufficient to endanger the patient's life. It may be irregular, rhythmical, or continuous.

It must be ascertained whether prior to the hæmorrhage the patient missed one or more periods, in which case pregnancy, normal or ectopic, is a possibility, and the hæmorrhage may be due to a miscarriage. In a certain percentage of cases of ruptured ectopic gestation there is no amenorrhœa; on the other hand, the last period is usually a few days early or late, and the loss is less than usual.

Bleeding before puberty, after the menopause, or after coitus demands full investigation.

(7) *Previous operations*: the number and their nature must be ascertained; also other forms of treatment and their results.

(8) *Bladder symptoms*: frequency of or pain on micturition; incontinence of urine, either as a continuous loss due to a bladder fistula, or an intermittent escape on coughing or straining—the result of a cystocele.

(9) *Other symptoms*: pelvic discomfort often described as “bearing down” pain, backache, sensation of “something coming down” in the vagina, dyspareunia, etc.

PHYSICAL EXAMINATION

- (1) *General.*
- (2) *Breasts.* (a) Inspection. (b) Palpation.
- (3) *Abdomen.* (a) Inspection. (b) Palpation. (c) Percussion. (d) Auscultation. (e) X-ray examination.
- (4) *Vulva.* (a) Inspection. (b) Palpation. (c) Pathological examination.
- (5) *Vagina.* (a) Inspection. (b) Palpation: (i) digital, (ii) bimanual: vagino-abdominal, recto-abdominal, vagino-recto-abdominal. (c) Exploration of the uterus. (d) Pathological examination.
- (6) *Rectum.* (a) Digital. (b) Inspection: (i) proctoscopy, and (ii) sigmoidoscopy. (c) Barium enema.
- (7) *Urethra and Bladder.* (a) Inspection including urethroscopy and cystoscopy. (b) Palpation, digital and vagino-abdominal. (c) Percussion. (d) Pathological examination. (e) X-ray examination.

(1) *General Examination.* The patient's general condition should be noted, whether obese, emaciated, cachectic, under-developed or normal.

(2) *Breast Examination.*

(a) *Inspection* may reveal (i) Pigmentation of the nipple and areola and striæ gravidarum indicating past pregnancy; (ii) Increased fulness and prominence of the superficial veins, which is supporting evidence of a diagnosis of present gestation; (iii) Retraction or elevation of one nipple as compared with the other, which is suggestive of the presence of carcinoma; (iv) Irregularity in shape or size of either breast, suggesting the presence of new growths, cystic disease or chronic inflammation. Inspection also reveals the state of development of the breast.

(b) *Palpation.* Both breasts should be palpated with the flat hand, as this will reveal general thickening or a localised induration. The latter is almost always due to a new growth or a cyst.

(3) *Abdominal Examination.*

(a) *Inspection* will reveal the general configuration of the abdomen which is usually more or less flat, but occasionally scaphoid in thin patients. When a projection appears in the hypogastrium the cause may be a pregnant uterus, an ovarian cyst, a fibroid or a full bladder. A sharply defined or irregular contour of the swelling is suggestive of a myoma. A smoothly rounded outline, especially at the upper limit, may be caused by a cyst or a gravid uterus; flattening of the most prominent part of the swelling with bulging in the flanks, free fluid. Limited mobility of the abdomen on respiration or on making special effort may be due to an inflammatory lesion such as salpingo-oöphoritis or peritonitis. Discoloration, such as a linea nigra or the presence of striae, is evidence of pregnancy past or present. Enlargement and prominence of the superficial veins indicates obstruction of the deeper veins, such as the inferior vena cava.

(b) *Palpation.* The hand of the examiner should always be warm and should be laid on the abdomen lightly, care being taken in palpating any region that is known to be or suspected of being tender. Palpation will reveal rigidity or flaccidity, local or general, of the abdominal wall; also outline, conformity, consistency, situation and movability of tumours or masses. The outline of a tumour may be smooth and regular, suggesting a cyst, or lobulated, consisting of rounded masses, indicating fibroids; the consistency may be firmly elastic as in a cyst, solid and firm as in a myoma, or varying intermittently as in pregnancy. The tumour may also be semi-fluctuating when there is encysted fluid due to a distended bladder or ovarian cyst. There may be a thrill transmitted from flank to flank, which is detected by placing a hand on one loin while the fingers of the other hand make light but sharp thrusts against the opposite side, the hand of an assistant being meanwhile pressed down on the mid-line of the abdomen to ensure that no surface wave is transmitted.

Pelvic tumours such as ovarian cyst, fibromyoma, gravid uterus or distended bladder rise to varying heights, but they can always be felt to have a connection deep in the pelvis, and the fingers cannot be thrust between the tumour and the pelvic brim. These tumours are usually more or less fixed, except in cases of pedunculated fibroids and ovarian cysts. A movable kidney may reach to the pelvis, but can always be pushed back to its normal position in the flank.

Rigid contraction of the abdominal muscles may be generalised or localised, and is a clear indication of peritoneal inflammation or

irritation. Its point of *maximum intensity* should be ascertained, e.g. whether in the right iliac fossa or over the lower part of both recti muscles.

Tenderness is pain produced by pressure or manipulation ; it may be superficial or deep, and is a most important sign. Superficial tenderness (hyperæsthesia) of certain areas of the skin is associated with lesions of pelvic viscera which have a correlated nervous relationship. Deep tenderness, often localised and consistently present, is important confirmatory evidence of an inflammatory lesion (e.g. salpingitis or appendicitis), acute invasion of the peritoneum, or hæmorrhage from a ruptured ectopic gestation. In nervous or hysterical patients, both superficial and deep tenderness may be exaggerated, but tend to disappear when the patient's attention is diverted.

(c) *Percussion* will reveal the difference between viscera containing gas and solid or cystic swellings. The majority of pelvic tumours such as fibroids, ovarian cysts, the pregnant uterus, and distended bladder when sufficiently large to cause abdominal swelling, come into contact with the anterior abdominal wall. Percussion immediately over any of these will be dull with a surrounding tympanitic area. In contrast to such findings, free fluid gives a dull note in the most dependent part and a tympanitic one in the highest. Shifting dullness is very characteristic of free fluid. On whichever side the patient lies, the upper flank gives a tympanitic note and the lower flank a dull note.

(d) *Auscultation* of the abdomen may reveal a uterine souffle ; this is a soft blowing murmur, synchronous with the patient's pulse, and is most commonly heard during pregnancy. On rare occasions a fibroid associated with uterine enlargement may produce the same effect. Foetal heart sounds are easily recognised and are of the utmost diagnostic importance. They are never heard before the eighteenth week of pregnancy, and seldom before the twenty-fourth. Occasionally soft thumping or thudding sounds, due to foetal movements, are heard at an earlier date. On rare occasions a funicular souffle can be made out ; it is fainter, higher in pitch, and double the rate of the uterine souffle.

(e) *Radiographic examination* of the abdomen may, by showing foetal bones, reveal the position of the foetus, its relative size, and the presence of single or multiple gestations, a calcified fibroid, or a lithopædion. X-rays are used to determine the presence of a malignant growth of

the intestine or stomach, and may be helpful in determining whether or not growths in the pelvis are secondary to malignant disease of the alimentary tract.

Before a diagnosis is made regarding an abdominal or pelvic swelling, the bladder should be emptied, preferably with a catheter, and the lower bowel cleared by an enema.

(4) *Vulval Examination.* The best method of obtaining a satisfactory view of the vulva is to have the patient on her back with the knees drawn up and the thighs well separated—lithotomy position. A fairly good view can be obtained by employing the left lateral, or better still the semi-prone (Sim's) position.

(a) *Inspection.* The following are noted: General development; presence of swelling, its situation and outline; ulceration, its situation, extent, outline, margin and base; warts, whether single, multiple, flattened, pigmented, or large and fungating; appearance of the skin, whether white and thickened as in leucoplakic vulvitis, or shining and "ironed out" as in the late stage of this disease; the presence of fissures associated with either of these stages; the presence and extent of excoriation of the vulva and surrounding skin (the skin may be red and the vulva enlarged when inflamed as the result of an acute infection or a primary syphilitic chancre); the presence of discharge which can be observed and its source discovered, whether from the vagina, the urethra, Skene's gland, Bartholin's glands, or from ulcers or warts. The perineum should be inspected for lacerations.

(b) *Palpation* is made to determine the presence of a swelling, and its situation, outline and consistency; whether it is hard and irregular and ill-defined as in a growth; indurated and very tender as in inflammation; whether rounded, smooth and semi-elastic in consistency as in a cyst; or whether a soft fluctuating area surrounded by an indurated zone, and tender as in an abscess.

Ulcers are palpated to determine whether or not the base is indurated or friable.

Warts should be palpated for any evidence of induration surrounding their base of attachment. A pigmented wart, however, should never be subjected to any squeezing or vigorous handling.

(c) *Pathological Examination.* Smears of discharge from any source should be examined microscopically to determine the nature of any organisms present. When necessary, cultures of the discharge

should also be made on suitable media. Sections may be cut from the edge of an ulcer or from portions removed at operation, and slides prepared for microscopical investigation.

(5) *Vaginal Examination.* An important preliminary to the examination is to ensure that the bladder, rectum and sigmoid colon are empty. Catheterisation is imperative when there are abdomino-pelvic swellings, and the surgeon should perform this duty himself, as the meatus may be difficult to find and the urethra is often greatly elongated.

A general anæsthetic may be required for a vaginal examination :

- (a) In the case of a virgin.
- (b) When there is marked tenderness of the vagina, introitus, or pelvic viscera.
- (c) When the abdominal muscles are unduly rigid.
- (d) When there is marked obesity.

(a) *Inspection.* A good light is essential, special lamps mounted within the speculum proving useful.

A speculum or retractor will be necessary. The most practical instruments are the broad and narrow vaginal retractors which have long blades. The former retracts the perineal body and posterior vaginal wall, the latter elevates the bladder and in this way an excellent exposure of the cervix and vaginal vault is obtained.

When the vagina is very small the narrow retractor may be used posteriorly, the bladder being lifted up with a pair of ring forceps. A bivalve speculum (Rotunda pattern) is useful when the surgeon is working single-handed or when the patient is in the dorsal position. A Fergusson tubular speculum affords access to the cervix for the purpose of inspection or treatment such as painting with antiseptics. A suitable lubricant is essential, the best being a compound of traga-canth and glycerine.

The vaginal entrance is inspected and the following points are noted: the hymen—whether intact, notched, or remaining as tags; the condition of the introitus—whether relaxed and gaping or tonically closed; the margin of the entrance—whether discoloured, e.g. red spots standing out in contrast to the pale pink of the surface of the vaginal entrance and vestibule—vascular degeneration, yellowish coloured combined with narrowing as in kraurosis, or violet coloured as in pregnancy;

the presence of discharge, its colour and character. A finger is passed into the entrance and the perineal body is retracted backwards, whilst the patient is encouraged to strain or bear down. Note is made of any bulging downwards of the anterior vaginal wall—cystocele, or of the posterior wall—rectocele, and the extent to which either of these sacculations protrudes or the vaginal vault and cervix descend.

A speculum or retractor is passed and the vaginal walls are viewed for colour, the presence of discharge, or swellings—their size, outline, contour, colour and situation.

The cervix is then inspected to determine its size, outline, colour, and the presence of lacerations, polypi or discharge ; the colour and character of the latter are noted, whether mucous, purulent or blood-stained. The condition of the external os is observed, noting whether it is round, oval or irregular in outline.

A small conical cervix indicates under-development ; enlargement is evidence of chronic inflammatory hypertrophy or endocervical growth ; irregular fungating or nodular hypertrophy is evidence of carcinoma. A red ring around the external os, showing in contrast to the pale pink of the normal vaginal portion, is characteristic of erosion. The presence of a deep notch, usually on one or both sides of the cervix, dividing it into an anterior and posterior lip, is due to laceration. The exposed inner surfaces of these lips frequently have the appearance of an erosion. Mucous discharge is clear in colour ; muco-purulent is opaque and yellow ; blood-stained is red or brownish.

Apart from prolapse of the walls, swellings of the vagina, when rounded, are indicative of cysts or fibromata ; small dark red nodules are produced by secondary chorionic carcinoma. An irregular ulcerating granular swelling is characteristic of carcinoma.

(b) *Palpation.* (i) *Digital.* The patient lies on her back with the head and shoulders slightly raised, the thighs flexed on the abdomen, and the feet resting on the couch. One or two fingers are inserted into the vagina, and note is made of the following :

Laxity or tonic closure of the vaginal entrance ; thickness or thinness of the perineal body, and tone of the levatores ani muscles : tightness or relaxation of the vaginal walls : the presence of swellings and their character, whether rounded in outline and smooth as in cysts and fibromata ; ill-defined, hard, nodular, ulcerated, in which the ulcer has heaped-up, rolled-out edges and a hard friable base, as in carcinoma ; any encroachment on the vaginal wall due to pressure from a tumour such as uterine or cervical fibroid, ovarian cyst, or

tumour in the broad ligament: any fixity of the vaginal wall as in cellulitis, particularly if this is associated with tenderness.

The cervix is palpated to determine its *consistency*, whether soft as in pregnancy, firm as in a healthy condition, or hard as in chronic inflammation or carcinoma. The *texture* is next ascertained, whether tough as in normal or even inflammatory conditions, or friable as in carcinoma. The *size*, whether small (conical) as in under-development; enlarged as in chronic inflammation; greatly elongated as in congenital hypertrophy; enlarged and friable as in the fungating type of carcinoma; or crateriform, friable and widely indurated as in the ulcerative type of cancer. Lacerations of the cervix and their extent and position are also determined.

(ii) *Bimanual Examination*. At least two fingers are inserted into the vagina. The examiner should stand at the patient's side so that his flexor muscles are relaxed, for palpation depends on muscle sense which is lost when these muscles are under tension. The left hand is placed on the lower abdomen to steady and press down the uterus, fibroids or cysts, and admit of combined palpation between the two hands.

The uterus is identified and its size, shape, outline, consistency, position, sensitiveness and mobility are determined. The surgeon should acquaint himself by experience with the characteristic "feel" of the normal uterus in regard to these points.

Conditions which render examination difficult are a full bladder, loaded rectum and sigmoid colon, retroversion of the uterus, rigid abdominal muscles, and obesity. The bladder and rectum should always be empty, and anæsthesia may sometimes be required to produce relaxation of the abdominal muscles.

When in a fat patient the retroverted uterus is difficult to locate, the line of the cervix should be followed. The uterus can then be felt through the posterior fornix to extend directly backwards, continuous with the vaginal portion of the cervix. A cochleate uterus may be difficult to recognise until palpated bimanually because the cervix and lower part of the uterus are directed backwards in a similar manner.

The *size* is determined by grasping the uterus with the fingers between the vaginal and abdominal walls, and by trained tactile sense estimating its breadth, length and thickness. The uterus is diminished in size in under-development and in superinvolution; it is enlarged in pregnancy, subinvolution, metropathia hæmorrhagica, and new growths. The supra-vaginal cervix may be elongated as the result of prolapse of the vaginal wall.

Shape. The normal uterus is slightly flattened antero-posteriorly. Alteration from this shape can be detected by bimanual examination. A finger is passed on *each side* of the uterus to determine its breadth and lateral configuration, and the walls are then palpated antero-posteriorly to determine the shape and thickness. The fundus is globular in early pregnancy, central corporeal fibroid, and carcinoma of the body of the uterus. It is irregularly enlarged when there are multiple myomata. Each half of a *double uterus* can often be felt.

Consistency. By feeling the uterus between the two hands, its consistency can be determined, whether harder or softer than normal, whether uniform or variable, and which parts are chiefly affected. Consistency is uniformly altered in early pregnancy, i.e. there is general softening. In chronic subinvolution and fibrosis uteri it is firm. At the third month of pregnancy it is variable, the lower segment being much softer than the fundus. When fibroids are present it is altered irregularly.

Position. It must be decided whether the uterus is in its normal position, retroverted, retroflexed, retroposed, or laterally deviated. Backward displacement may be congenital or acquired, or may follow parturition. The uterus may be dragged backwards by adhesions resulting from salpingitis and pelvic peritonitis; it may be drawn backwards by a fibroid in the posterior part of the fundus, or be pressed backwards by a large anterior myoma or ovarian cyst. The fundus may remain in a backward position during pregnancy, in which case the cervix is pushed high up and forwards. The uterus may be pressed laterally by an effusion in the cellular tissues, or by an ovarian tumour or myoma on the opposite side. It may be drawn laterally by adhesions or by scar tissue in the broad ligament.

Mobility. Note is made of any fixity either of the fundus or of the cervix. The fundus has a considerable range of movement in both vertical and lateral directions. Fixity in a retroverted position is almost always due to salpingitis; in a forward and upward position to operation. The cervix has a small amount of up-and-down movement which may be tested by grasping it with a vulsellum. The chief cause of limitation of movement is infiltration of the peri-cervical tissues with carcinoma.

Exploration of the Fornices. The fornices are palpated with the fingers. The presence of tenderness or of a tumour or swelling should be noted. The point of maximum tenderness should be determined together with its relation to the movement of the uterus. Tenderness

is usually due to inflammation of the tubes, ovaries or pelvic peritoneum.

When a *tumour* is discovered, the following points must be noted : Exact situation, relation to the uterus, mobility, tenderness, consistency, outline, and size. Masses attached to the uterus and which seem to be incorporated with it are myomata, inflammatory swellings of the tubes and ovaries, and occasionally an inflamed ovarian tumour which is adherent to the uterine body.

Inflammatory swellings are usually very tender and often associated with constitutional symptoms, e.g. pyrexia. Swellings felt apart from the uterus may be pedunculated fibroids or tumours of the ovary. Fibroids are rounded, very firm, and frequently multiple, but are seldom tender to pressure. Ovarian cysts are usually rounded, tensely elastic, not tender, and sometimes freely mobile.

Pelvic hæmatocele is felt as a soft fluctuating mass in the central part of the pelvis, surrounded by an irregular firm zone, and is usually tender.

Solid growths of the ovary are firm, irregular, occasionally mobile and usually bilateral. Massive carcinomatous growths of both ovaries produce hard irregular nodular swellings, which are ill-defined, attached to the uterus and pelvic walls, and frequently tender on pressure.

The characteristic "feel" of the normal ovary should be recognised. It is always tender, and pressure produces a "sickening" sensation. Normally, it is about the size of the distal phalanx of the middle finger. That on the right side can be felt by inserting the finger high into the fornix and pressing the ovary very gently against the pelvic wall or by palpating it bimanually. The left ovary is rather difficult to feel satisfactorily. The left hand may be used for this purpose, or the patient may roll over on to the right side.

Prolapsed ovaries are frequently associated with retroverted uterus, and are felt as small, smooth, rounded mobile bodies behind and on each side of the fundus. The normal Fallopian tube is not palpable. A gravid tube is so excessively tender that it cannot possibly be examined satisfactorily unless the patient is under a general anæsthetic, when a thickening to one side of the uterus may be made out, lying apart from the ovary.

The condition of the cellular tissues is investigated. Scar tissue, as the result of lacerations extending into the base of one of the broad ligaments, can be felt as an indurated ridge running laterally across one fornix; occasionally the condition is bilateral. A malignant infiltration of the vaginal vault and peri-cervical tissues is felt as a

firm solid mass, most marked laterally, but also to a varying degree behind and in front of the cervix.

Recto-abdominal examination is preferable in virgins and in those cases where the vagina is too tender to permit satisfactory palpation. By this method of examination the cervix, when invaded by endocervical carcinoma, can be felt to be enlarged, hard, very firm and barrel-shaped. The extent of a carcinomatous induration laterally towards the pelvic wall can be more readily felt per rectum as can also inflammatory infiltration or malignant induration of the uterosacral ligaments.

Combined Recto-vaginal Examination. With the first finger in the vagina and the second in the rectum, or occasionally with the first finger in the rectum and the thumb in the vagina, the deep part of the pouch of Douglas can be grasped, and any structure lying there, such as an ovary, can be distinctly felt. With the thumb and finger method the condition of the vaginal vault and bases of the broad ligaments can often be very accurately determined.

(c) *Exploration of the Uterus.* This is one of the most important steps in the investigation of diseases of the uterus. The cervix must be dilated if this has not already occurred as the result of a recent miscarriage or the extrusion of a myomatous polyp.

The length of the uterine cavity is determined with a sound. The walls of the cavity are then explored with either the finger or a curette to investigate the contour of the inner surface, which may be altered by the presence of a growth such as a fibroid (causing a rounded smooth prominence), or a carcinoma (causing rough ragged nodules from which fragments can be readily cut with a curette). A polyp, either mucous, placental or myomatous, may also be detected. Further material, such as strips of endometrium, portions of malignant growths, or products of conception, may also be removed with the curette and examined by the naked eye or microscope.

In the case of inversion of the uterus, the use of a sound will reveal shortening of the cavity.

(d) *Pathological Examinations.* These include (i) naked-eye, and (ii) microscopical examinations of discharges or fragments removed from the interior of the uterus with the curette, or of small excised portions from the cervix or from any other affected part of the genital tract.

Smears may be made from discharges from the cervix, interior of the uterus, urethra, or vagina. These are suitably fixed and stained

and then examined microscopically to determine whether or not organisms are present, and if so their type. Further, *cultures* may be made on suitable media by taking swabs from the cervix, interior of the uterus, or urethra. In examining fragments removed with the curette, it is helpful to be able to make a reasonably accurate diagnosis by means of their macroscopic appearance and physical characteristics, as, when carcinoma of the body is discovered in this way, it may be desirable to proceed at once with the operation of total hysterectomy. Endometrium removed with the curette comes away in strips which are soft and shiny, have a mucoid appearance, and are of moderately tough texture. Carcinomatous fragments are never obtained in strips but in rounded or irregularly shaped lumps of various sizes; these have a granular appearance, are firm in consistency, and friable in texture. Fragments of retained products vary considerably in colour from dark red to dull grey; they are usually soft, and have a fibrillary appearance. Microscopical appearances of the various tissues are discussed under the respective sections.

(6) *Rectal Examination.* When indeterminate masses are discovered in the pelvis, the diagnosis may be assisted by digital examination of the rectum, by proctoscopy, sigmoidoscopy, or radiologically after the injection of a barium enema.

(7) *Urethra and Bladder Examination.*

Palpation (see page 2196). *Percussion* (see page 2197).

Urethroscopy, and particularly cystoscopy, are important aids to gynaecological investigations; these are fully discussed under the section dealing with diseases of the urinary tract. In all cases of urinary fistula and most cases of carcinoma of the cervix a cystoscopic examination may yield valuable information.

CHAPTER II

VULVA

THE vulva may be the site of many and varied affections, which will be considered under the following headings :

- (1) Malformation.
- (2) Inflammation.
- (3) Obscure lesions.
- (4) Swellings not due to new growths.
- (5) New growths : (a) innocent : (b) malignant.

MALFORMATION

- (a) Persistent urogenital sinus.
- (b) Epispadias.
- (c) Recto-vaginal communication.
- (d) Pseudo-hermaphroditism.

Persistent urogenital sinus, or hypospadias. This is a condition in which the bladder and vagina open into a common cavity. It is due to incomplete development of the anterior wall of the vagina and floor of the bladder. If the sinus is long and narrow and the bladder sphincter has developed, there may be control of urine, but more often incontinence of urine occurs.

Epispadias. This is a condition in which the anterior wall of the urethra is absent. It is usually associated with ectopia vesicæ, in which condition the pubic bones have failed to unite.

Recto-vaginal communication. The cloacal aperture of the rectum persists and opens between the hymen and fourchette, the anal pit having failed to open into the rectum.

Pseudo-hermaphroditism. Various anomalies of development of the external genitalia are seen, and occasionally it may be impossible to determine the true sex of a child. In these indeterminate cases it is better to bring up the child as a boy, as in nine-tenths of these cases the male characteristics will be found to predominate.

INFLAMMATION

The chief causes of inflammation of the vulva are infections with pathogenic organisms. These infections are : (a) specific, or (b) non-specific.

- (a) Specific infections :
 - (i) *Gonorrhœa*.
 - (ii) Syphilis.
 - (iii) Soft chancre.
 - (iv) Tuberculosis.
 - (v) Diphtheria.
- (b) Non-specific infections :
 - (i) Noma vulvæ.
 - (ii) Gangrenous intertrigo.
 - (iii) Furunculosis.

Specific Infections

Gonorrhœa. This is due to infection with the diplococcus intracellularis of Neisser, usually conveyed by coitus, except in children among whom it may be spread by fingers, clothes, towels or utensils. It may become epidemic in institutions. Gonococcal vulvitis is usually only part of a wider infection, such as urethritis or cervicitis. The earliest symptoms are itching for two or three days, and then tenderness of the vulva, scalding pain on micturition, and a thin purulent discharge. The diagnosis is confirmed if the diplococcus is demonstrated on microscopical examination of smears from the discharge. Whilst the primary infection is usually in the urethra or cervix, there may be extension to Bartholin's duct and gland causing inflammation, suppuration, or cyst formation, or to the rectal mucosa causing proctitis. Spread via the lymphatics to the inguinal glands will result in adenitis, occasionally suppurative. In young girls gonorrhœa is frequently manifested as an acute vulvo-vaginitis, later becoming chronic.

Syphilis. The primary sore is usually single, but contact sores are occasionally seen. It may be found on any part of the external

genitals. The typical hard chancre observed in men is seldom seen in women, but rather a condition is which the labium is very swollen, livid and firm. The ulcer is often small, with a dry irregular surface and no induration of the base. Occasionally a raised hard papule is found. The inguinal glands are enlarged, hard and discrete. It is important to make a diagnosis so that treatment may be instituted early. The condition must be distinguished from squamous epithelioma, and if doubt exists a section should be taken and examined under the microscope. Before doing this, however, a smear should be investigated, preferably by dark-ground illumination if available. The base of the ulcer should be cleansed and dried, and then scraped gently with a scalpel till slight oozing occurs. When this has ceased, the base of the ulcer is squeezed and as a bead of serum exudes it is picked up on a slide, mixed with a finely divided emulsion of Indian ink, spread into a thin film and allowed to dry. Under a $\frac{1}{2}$ inch oil-immersion lens, the spirochæta pallida may be seen surrounded by the black emulsion.

Mucous tubercles of the vulva or surrounding skin are examples of secondary syphilitic lesions. They are accompanied by other manifestations, such as a typical skin rash, sore throat, alopecia or glandular enlargement.

Tertiary syphilitic lesions of the vulva are exceedingly rare. They occur as deep ulcers, healing in one part and spreading in another, and followed by much cicatrisation. Gummata are scarcely ever seen.

Soft Chancre. This is an acute infection due to Ducrey's bacillus. It is characterised by a number of papules on the labia or clitoris which break down, forming ulcers with a yellowish base and well-defined elevated edges. It is often present together with a gonococcal infection and must be differentiated from the condylomata of secondary syphilis. The inguinal glands are usually enlarged and frequently suppurate. These sores are highly infective and contact ulcers are common.

Treatment. Hot hip baths for fifteen minutes at a time relieve pain and promote healing. An excellent dressing is gauze soaked in argyrol 20 per cent and covered with oiled silk and a gamgee pad.

Tuberculosis of the vulva, a rare infection and usually a primary one, is similar to tuberculosis of the skin in any other part of the body. The ulcers have pale, soft granulation tissue covering the base, and undermined edges. They are extremely irregular in outline, have a tendency to spread in one part and heal in another, and are usually accompanied by œdema and swelling of the labia. The

condition must be distinguished from syphilis, elephantiasis and cancer. A section should be taken for microscopical examination, when the typical giant-cell systems will suggest the nature of the lesion.

Treatment. The most satisfactory treatment is excision of the vulva, combined with general measures, such as fresh air, nutritious food and vitamins.

Diphtheria of the vulva, due to the Klebs-Löffler bacillus, sometimes occurs in children. It is important to keep the possibility of its occurrence in mind, as valuable hours may be lost before serum treatment is instituted.

Non-specific Infections

Noma vulvæ is an acute spreading gangrene of the vulva and skin of the thighs. Usually arising as a complication of the exanthematous fevers, it is a serious condition, and is likely to end fatally if the causative organism—*streptococcus pyogenes*—spreads to the blood stream.

Treatment must be vigorous. Under general anæsthesia the advancing edge of the ulcer is painted with fuming nitric acid. If this fails to stay the spread, wide excision should be performed and the raw area dressed with gauze soaked in glycerine. Intravenous injections of salvarsan should also be tried.

Gangrenous intertrigo may occur on the vulva and thighs of young children. Painful ulcers with a sloughing base are formed. There is no marked tendency to spread, and the condition is not so serious as *noma vulvæ*.

Dry iodoform powder dusted over the ulcers is the best form of treatment.

Furunculosis. Boils due to the *staphylococcus pyogenes* may occur on the vulva and should be treated, as those arising elsewhere, by hot fomentations, vaccines and manganese injections.

OBSCURE LESIONS

Lesions of obscure cause but which present well-recognised characteristics are :

- (a) Vascular degeneration.
- (b) *Kraurosis vulvæ*.

- (c) Esthiomene.
- (d) Leucoplakic vulvitis.
- (e) Elephantiasis.
- (f) Herpes.
- (g) Pruritus vulvæ.

Vascular Degeneration is a disease that affects the vaginal entrance and urethral meatus, usually at or after the menopause. It appears as dark red patches of varying sizes (fig. 1149). In these the epidermis is very thin and there is a wide dilatation of the superficial capillaries of the corium with an accompanying leucocytic infiltration.

The symptoms are pain, tenderness, dysuria, and dyspareunia.

Treatment. The disease is chronic and difficult to treat, and the patient should be warned that progress will be slow. It is important to deal with discharges from the uterus, cervix, or urethra. An anæsthetic and antiseptic ointment containing chlorethane 5 per cent with carbolic acid 0.25 per cent and borocaine 10 per cent will give relief and promote healing. When pain and tenderness are marked, the areas should be excised and the cut edges sutured.

Recently I have tried injections of œstrin (250,000 international units a week) with encouraging results.

Kraurosis Vulvæ is a progressive shrinking of the tissues of the vestibule and vaginal entrance, occurring either after the menopause or in young women following removal of both ovaries. In the early stages there is leucocytic infiltration, later followed by atrophy of the deep layers of the epidermis and marked shrinking of the corium which may cause the urethra to be retracted up the vagina and the vaginal entrance to be narrowed. In the stage of contraction, the tissues have a yellowish colour. Pain and dyspareunia are marked symptoms in the early stages, but tend to disappear later.

Treatment consists of intramuscular injections of 500,000 international units of œstrin once or twice a week to arrest shrinkage and relieve discomfort. Where necessary an operation for enlargement of the vagina may be performed (see page 2418).

Esthiomene. This is a very rare condition, characterised by massive hypertrophy due to new-formed fibrous tissue. All parts of the vulva are affected, the disease usually starting near the fourchette. Ulceration takes place and heals with much cicatrisation. The

cause of esthiomene is not known, though there has been much speculation and discussion as to its ætiology. It was first thought to be tuberculous, then syphilitic, but there is nothing definite to support either view.

Treatment. Excision of the vulva is the only satisfactory form of treatment (see page 2382).

Leucoplakic Vulvitis (fig. 1150) is more common than kraurosis, from



Fig. 1149.—VASCULAR DEGENERATION. THE VAGINAL ENTRANCE IS SURROUNDED BY DEEP RED PATCHES, WHICH EXTEND FORWARD, AROUND THE URETHRA, AND OVER THE VESTIBULE. THE LESSER AND GREATER LABIA ARE UNAFFECTED.

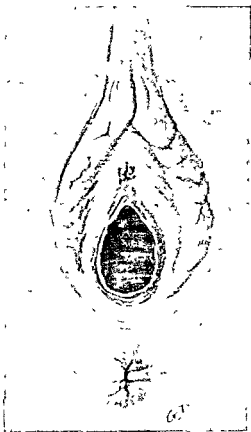


Fig. 1150.—LEUCOPLAKIC VULVITIS. A COMPARATIVELY EARLY STAGE IS SHOWN. THE SKIN OF THE LESSER LABIA, FRENUM CLITORIDIS, AND ALSO THAT ON THE INNER SIDES OF THE GREATER LABIA OVER THE PERINEUM AND AROUND THE ANUS IS GREATLY THICKENED. THE VAGINAL ENTRANCE AND URETHRAL MEATUS REMAIN UNAFFECTED.

which it must be differentiated. It usually occurs at or near the menopause, but never in young or very old women. The affected parts are the greater and lesser labia, the clitoris and fourchette, and sometimes the perineal and peri-anal skin. The vestibule and vaginal entrance are never affected, and in this respect the condition stands in contrast to kraurosis. In the early stages the skin is wrinkled and swollen, later becoming shrunken, white and shiny, and the vulva has a flattened

appearance. Fissures appear, especially at the fourchette and the mid-line of the perineum, and squamous epithelioma is liable to develop.

Constant intolerable itching is the chief symptom. When fissures form, or scratching leads to suppuration, pain may be added and the discomfort of the patient become extreme.

Treatment. Swabbing the affected part with 1 in 40 carbolic lotion affords temporary relief. In pronounced cases, prussic acid lotion (hydrocyanic acid 10 minims in water 1 oz.) is highly effectual, but being dangerous it can be used only by intelligent patients.

When treatment has failed to give relief, and in all cases when fissures have appeared, excision of the vulva is indicated (see page 2382).

Elephantiasis of the Vulva, due to the *filaria sanguinis hominis* obstructing the lymphatics, is seldom seen in western countries, but cases of nodular overgrowth of the labia are occasionally encountered. The pathology of this latter condition is unknown. Where there is much hypertrophy the vulva should be excised.

Herpes of the Vulva resembles herpes zoster occurring elsewhere in the body, in that crops of vesicles follow the distribution of a cutaneous nerve and are associated with severe pain and irritation. Relief may be obtained by the application of a 2 per cent carbolic acid ointment, but recurrences are frequent.

Pruritus Vulvæ is a condition in which pronounced and troublesome itching is a characteristic and distressing symptom, and may reach a stage where it becomes intolerable. The condition may be due to eczema, such as occurs in other parts of the body, or it may be the early stage of leucoplakic vulvitis. Other causes are discharges from the uterus, cervix or urethra, or from a Bartholin's gland; vesico-vaginal fistula; recto-vaginal fistula; thread worms; pediculi; or filth.

In all cases the urine must be examined for sugar, as vulval itching is also a common symptom of diabetes.

Treatment. The vulva should be cleansed and dried by pressure—not rubbing. Lotions such as carbolic acid 1 in 40, or perchloride of mercury 1 in 2000, should be swabbed over the vulva, or lint soaked in liquor plumbi subacetatis fortis, 1 part in 8 of milk, may be applied as a compress. Cases of intractable itching should be treated by X-rays. Where palliative measures fail, excision of the vulva should be advised.

Vulval congestion in pregnancy, which may also be mentioned here, may cause very severe itching, tenderness, or aching pain. Cervical secretion, which is free at this time, greatly aggravates the condition. After labour the symptoms quickly disappear.

Treatment. The vulva should be washed with ether soap and hot water, rinsed thoroughly and dried by pressure with gauze or a soft towel. The following lotion is then applied : Menthol and camphor 10 grs. of each in paroline 1 oz. A stronger lotion is perchloride of mercury 1 in 4000. After application of the lotion, a pressure pad, held in place with a tight binder, will afford further relief by reducing the congestion.

SWELLINGS NOT DUE TO NEW GROWTHS

These are :

- (a) Cyst of Bartholin's gland and duct.
- (b) Sebaceous cysts.
- (c) Hydrocele of the canal of Nuck.
- (d) Blood cysts.
- (e) Varicocele.
- (f) Herniæ : inguinal, posterior labial and perineal.

Cyst of Bartholin's gland and duct (fig. 1151). This is due to an infection in the duct, usually gonococcal, which causes occlusion. The duct and gland spaces then become filled with secretion which is rich in mucin. The cyst can be felt as a rounded fluctuating tumour at the posterior end of the labium minus. It must be distinguished from a solid growth—adeno-carcinoma, which is painless and is felt as a hard, ill-defined thickening. This type of growth is, however, exceedingly rare.

Treatment. Complete excision is the only satisfactory measure. (See page 2386.)

Sebaceous cysts resulting from occlusion of the ducts and distension of the gland spaces with sebaceous material may be found on any part of the vulva, but are very rare on the moist surfaces. They form rounded swellings incorporated with the skin. Sometimes they suppurate, and on rare occasions squamous epithelioma may arise from the lining cells.

Treatment consists of incision and removal of the epithelial lining.

Hydrocele of the canal of Nuck is a swelling produced by an accumulation of watery fluid in the unobliterated peritoneal process which accompanies the round ligament through the inguinal canal into the labium majus. The condition must be distinguished from inguinal hernia. There is no impulse on coughing, and the swelling is dull on percussion and translucent.

Treatment. The cyst should be removed by dissection.

Blood Cysts. These are accumulations of blood, usually in one labium. They are due to rupture of a vein, generally during parturition, seldom as the result of an accident. The skin overlying the swelling is of a deep violet colour. Infection frequently follows. These effusions are often absorbed, but should this fail to take place or infection supervene, incision and drainage must be undertaken immediately.

Varicocele is an aggregation of varicose veins, usually developing during pregnancy, and is a condition which must be distinguished

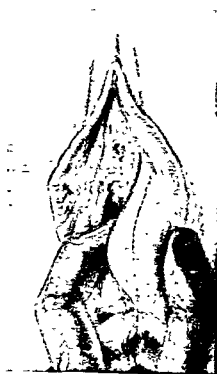


Fig. 1151.—CYST OF BARTHOLIN'S GLAND. THE INCISION FOR REMOVAL OF THE CYST IS INDICATED BY A DOTTED LINE.

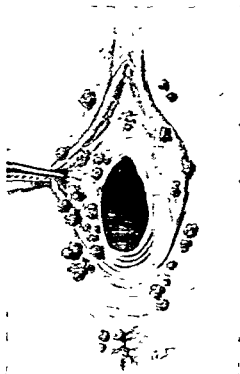


Fig. 1152.—CONGENITAL WARTS. NUMEROUS SMALL PAPILLOMATOUS GROWTHS ARE SEEN SCATTERED OVER THE GREATER AND LESSER LABIA AND THE SKIN OF THE PERINEUM, PERI-ANAL REGION AND INNER SIDES OF THE THIGHS.

from hernia. It causes aching pain on standing or walking, and the swollen veins may be felt like a bag of worms as in cases of male varicocele. On straining or coughing the swelling increases, but it is dull on percussion and becomes flaccid when the patient lies down. The veins usually shrink after delivery.

Treatment. Formerly ligation and removal was the only treatment, but Maingot has shown that sclerosing injections give uniformly good results and the patient is not laid up. This treatment may be given during pregnancy, but this is only advised when there is great discomfort.

Herniæ. Three types occur : inguinal, posterior labial, and perineal.

Inguinal hernia is fairly common. In this condition there may be a protrusion of bowel, omentum, bladder or ovary into the process of peritoneum which accompanies the round ligament through the inguinal canal.

Posterior labial hernia is the protrusion of a viscus through a congenital defect in the pelvic diaphragm in front of the broad ligament. A process of peritoneum is carried through this defect and a swelling is formed at the posterior end of the labium majus.

Perineal hernia is a protrusion in the perineum due to a defect in the pelvic diaphragm behind the broad ligament.

All these herniæ tend to protrude on standing, have an impulse when the patient coughs, can be reduced by manual pressure, and, if they contain bowel, are resonant on percussion. The two latter types of herniæ are exceedingly rare.

Treatment consists of the ligation of the sac after returning the contents to the abdomen, and, where possible, closure of the defect in the wall.

NEW GROWTHS OF THE VULVA

New growths of the vulva are : (a) Innocent ; and (b) Malignant.

Innocent Growths

- (i) Fibroma.
- (ii) Fibromyoma.
- (iii) Neurofibroma.
- (iv) Lipoma.
- (v) Papilloma.

- (vi) Adenomyoma or endometrioma.
- (vii) Angioma.
- (viii) Lymphangioma.

Fibroma occurs as a soft growth on one of the greater labia, at first sessile, later becoming pedunculated. It is due to an overgrowth of subcutaneous connective tissue, and the skin covering it contains all the ordinary skin structures, such as hair follicles, and sebaceous and sweat glands.

Treatment. These growths should be excised.

Fibromyoma is a rare growth found in the upper part of the labium majus arising in the round ligament. It has the same structure as a uterine fibroid.

Treatment. No treatment is required unless the growth is increasing in size, causing pain, or becoming tender, when it should be removed.

Neurofibroma is a rare tumour growing in the sheath of a nerve twig in the corium or subcutaneous tissues. It is essentially a fibroma growing in the connective tissue of the perineurium. Pain on pressure, causing a sensation like an electric shock, is a characteristic symptom.

Treatment. The nodule should be excised.

Lipoma. This tumour is composed of fat, is encapsulated, slow growing, and is essentially benign. It occurs in the labium majus and may attain to a large size. Softness, lobulated outline and mobility distinguish it from a malignant growth. If increasing in size, it should be removed.

Papillomata are most commonly seen in clusters as gonorrhœal warts which may remain small and discrete or may cover the whole vulva and extend up the vagina and on to the cervix (fig. 1152). Sometimes clusters may form a mass, like the head of a cauliflower. The tumour is moist from transudation of lymph which decomposes, causing a foul odour. Pathologically the condition is a branching overgrowth of the normal papillæ of the skin with great thickening of the epidermis.

Treatment. The warts should be removed with a curette, and the gonococcal infection treated.

Non-gonorrhæal papilloma occurs on the vulva as on the skin elsewhere. It is single and may be the size of a sixpence. The skin papillæ are enlarged and their lymphatics are dilated and filled with proliferating endothelium. According to Stevens ("Diseases of Women." *Univ. of Lond. Press*, 1933) it is a benign lymphatic endothelioma. If pigmented it may become malignant.

Treatment. The tumour should be excised, together with its base.

Adenomyoma or endometrioma is a growth which may sometimes occur at the lower end of the round ligament, bulging through the inguinal ring and causing a swelling of the upper end of one of the labia majora. It is composed of fibro-muscular cells containing gland spaces and stroma cells similar to those in the endometrium; during menstruation hæmorrhagic exudate escapes from the stroma, and the growth swells and becomes tender.

Treatment. The tumour should be removed.

Angioma. This occurs as a localised mass of dilated capillary vessels in the corium, and produces a slightly projecting, bright cherry-red area on the labium.

Treatment. Freezing with carbon dioxide snow, excision, or the diathermy spark are the usual methods, the last mentioned being the best. A lens is pressed over the growth until it is blanched; gradually this pressure is released and the redness returns in several isolated spots, from each of which it radiates peripherally. These spots are the trunk vessels. Each is marked and the diathermy spark is directed on to it to produce coagulation. The radiating capillaries subsequently shrink and disappear.

Lymphangioma is rare in the vulva. Usually it is multilocular, lobulated and irregular in shape, and is attached to the skin. Microscopically it is seen to be made up of dilated lymphatic spaces lined with flattened endothelium and filled with clear watery lymph. It is identical in structure with the cystic hygroma seen in the neck and axilla of infants.

Treatment. The swelling should be excised.

Malignant Growths

- (i) Squamous-celled carcinoma (epithelioma).
- (ii) Carcinoma.

- (iii) Rodent ulcer.
- (iv) Melanoma.
- (v) Sarcoma.
- (vi) Endothelioma.

Squamous-celled carcinoma (epithelioma) may occur on any part of the vulva, but it is most frequently seen in the neighbourhood of

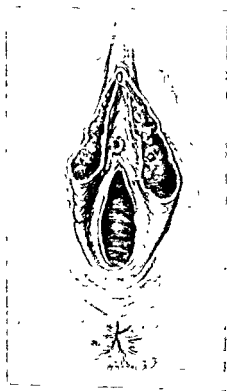


Fig 1153.—CARCINOMA OF THE VULVA. HORSE-SHOE SHAPED GROWTH AFFECTING THE FRENULUM CLITORIDIS AND BOTH LABIA MAJORA.

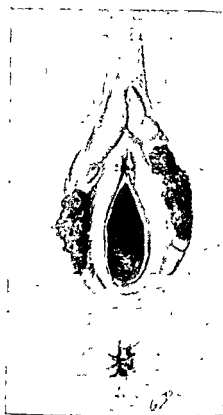


Fig 1154.—CARCINOMA OF THE VULVA. BILATERAL CARCINOMA OF THE LABIA MAJORA IS HERE SEEN ARISING IN A CASE OF LEUCOPLAKIC VULVITIS.

the clitoris, after which the vestibule, the meatus of the urethra, and the surface of the labia majora appear to be attacked with equal frequency (fig. 1153). Leucoplakic vulvitis is associated with most cases of squamous-celled carcinoma, and must be regarded as a definite precursor (fig. 1154).

In the early stages there is an indurated nodule which ulcerates because of its poor blood supply. Later, two well-marked types may be distinguished—the fungating, producing a cauliflower-like mass of growth, and the excavating ulcer type. In this latter the ulcer has a

hard granular-looking base, the edges are hard, everted and irregular in outline, and there is considerable surrounding induration. The inguinal glands are involved early.

On microscopical examination downgrowths may be seen in the deep layer of the epidermis. At the margin of the growth the healthy layers of epithelial cells merge gradually and imperceptibly into the region where there is greatest proliferation. As is typical of epithelioma elsewhere, cell-nests form, and the more centrally placed of these undergo keratinisation. Sometimes the growth is not so typical; there are no nests, only masses of heaped-up cells which invade the corium and subcutaneous tissues, tend to become rounded, and lose all resemblance to the original epithelial cells.

Diagnosis. When ulceration or fungation occurs, the nature of the lesion is fairly evident, especially when the indurated base is noted. If there is the slightest doubt, a small segment should be removed for microscopical examination. If seen in the early stages when a small hard nodule is present, the condition must be differentiated from a primary syphilitic chancre or an early tuberculous focus.

Symptoms. Pain is usually an early symptom because of invasion of the nerve endings in the skin. Discharge and slight bleeding are superadded when the ulcerating or fungating stages are reached. A secondary vulvitis is frequently set up from the irritating discharges, and burning and smarting follow.

Treatment. Excision of the growth, with a wide margin of skin all around and as deep as possible, should be carried out at once, or the vulva should be amputated, together with the glands in both groins. (See page 2382.)

Carcinoma arises in a Bartholin's gland or its duct, either in the form of an adeno-carcinoma or as a columnar-celled growth. It is, however, very rare. It begins as an indurated swelling deep to the posterior part of the labium minus on one side, and rarely causes pain until the skin is involved. Painless induration is an indication of its nature.

Treatment. The growth should be removed by a wide and deep excision, together with the glands in both groins.

Rodent Ulcer. This is very seldom seen on the vulva. It is a malignant epithelial growth spreading deeply and peripherally like carcinoma but differing in that it never spreads via the lymphatics or the blood stream.

Treatment. Wide and deep local excision should be performed or, preferably, radium applied.

Melanoma. This is a pigmented tumour of rare occurrence, usually seen in elderly women on the greater or lesser labia or on the clitoris. Often it is preceded by a pigmented skin mole. The growth has been called on the one hand melanotic sarcoma and on the other melanotic carcinoma. Stevens is of the opinion that it is a melanotic endothelioma. Microscopically it is composed of alveolated masses of large cells enclosed in a connective tissue stroma and containing granules of a brownish pigment-melanin, which is also seen in the adjacent connective tissue cells. Spread of the growth is exceedingly rapid, surrounding tissues are quickly infiltrated, and there is wide dissemination via the lymphatics and blood stream. It is the most malignant of all known growths, and the prognosis is very bad.

Treatment. The treatment is wide and deep excision, together with removal of the glands in both groins and the lymphatic tracts connecting them with the growth. Deep X-ray treatment should be applied after the wound has healed.

Sarcoma. This is exceedingly rare, especially as a primary growth. There is a secondary type which arises from the pelvic bones and periosteum. In type it may be round-celled, spindle-celled, giant-celled, or a mixture of all these. Growth is very rapid, and the swelling is fixed and markedly vascular.

Treatment. Where possible the growth should be removed at once and this should be followed by deep X-ray applications. Inoperable cases should be treated with radium or X-rays.

Endothelioma. This growth occasionally occurs apart from melanoma. Where the growth originates in a Bartholin's gland it simulates a circumscribed tumour such as is commonly seen in the parotid.

Treatment. Wide removal of the growth, together with the lymphatic glands and vessels should be carried out early, this being followed by deep X-ray exposures.

CHAPTER III

URETHRA

MALDEVELOPMENTS

MALDEVELOPMENTS of the urethra are rare, but may occur as a persistent urogenital sinus—*hypospadias* or *epispadias* (see page 2206).

INFLAMMATION

Acute inflammation of the urethra is most commonly due to the gonococcus; mixed infection with the staphylococcus may follow later. Skene's tubules and the glands in the floor of the urethra may become infected, giving rise to a sub-urethral abscess.

Symptoms and Signs. Scalding pain on micturition is a constant and characteristic symptom. The urethra is very tender on pressure, and if stroked with the finger from above downwards, pus can be expressed. A sub-urethral abscess is a very painful, rounded, indurated swelling under the urethra.

Treatment. In the acute stages the urine should be rendered alkaline by giving sodium citrate in large doses, e.g. 1-2 drachms three-hourly. Local treatment consists of painting the urethra with 5 per cent cocaine solution to anaesthetise it, followed by the insertion of a small bougie of argyrol 20 per cent in oil of theobroma. A pad covering the urethra keeps this in place and prolongs the application. A sub-urethral abscess should be opened and freely drained through an incision on the vaginal aspect.

SUB-URETHRAL CYST

Occasionally a gland follicle in the floor of the urethra becomes enlarged and forms a cyst which communicates with the urethra. It can be felt as a rounded swelling and is not painful or tender. It

empties on pressure, and a probe can be passed from the urethra through the duct into the cystic space.

Treatment. The cyst should be dissected out of its bed and its duct ligated. The cavity is then obliterated with catgut sutures.

CARUNCLE

This is a common condition and may occur at almost any age. It is a small, rounded, cherry-coloured swelling which occurs on the posterior edge of the urethral meatus. It may be long and pedunculated, or may have a broad base extending some distance up the floor of the urethra. Histologically the growth is a granuloma. Three types of tissue may be found: (a) granulation, (b) fibrous, or (c) glandular.

Granulation caruncles consist of a mass of young connective tissue and dilated capillary vessels, together with leucocytic infiltration, the whole being covered by stratified epithelium.

The *fibrous* caruncle is a later stage of this, the fibrous tissue becoming more dense and the vessels compressed.

The *glandular* type is produced by infoldings of the stratified epithelium of the surface, producing crypt-like spaces.

Symptoms. Pain on micturition, burning and irritation of the urethral meatus, tenderness on pressure, and dyspareunia are the most common symptoms. Slight bleeding occasionally occurs on exertion or after coitus.

Treatment (see page 2390).

PROLAPSE OF THE URETHRAL MUCOUS MEMBRANE

This is a rare condition which may occur at any age from childhood onwards. A roll of mucous membrane protrudes from the meatus, the urethral canal being in the centre. It is easily distinguished from caruncle where there is a single swelling on the posterior lip of the urethra, and from vascular degeneration where there is no swelling, but scattered red patches.

Symptoms. These are the same as those of urethral caruncle, namely, pain and tenderness in the region of the urethra.

Treatment (see page 2392).

CARCINOMA

This is a squamous-celled epithelioma, usually arising at the meatus or in the vestibule adjoining it. In the early stages it is a hard nodule with an indurated base and tends to become ulcerated. Pain is an early symptom, and slight bleeding is present when there is ulceration.

Treatment. If seen in the early stages the growth should be removed, together with the inguinal glands in both groins. If there is much involvement of the urethra, or if the growth is at all advanced, removal is impossible and radium treatment should at once be instituted.

INCONTINENCE OF URINE

This may be congenital, due to hypospadias or to ectopia vesicæ. It is commonly due to a vesico-vaginal fistula resulting from injury during labour. In such cases there is a definite history of incontinence starting 10-14 days after delivery.

Incontinence of urine must be distinguished from *retention with overflow* which in women is usually caused by an incarcerated, retroverted, gravid uterus, in which condition the patient will complain of hypogastric pain, and desire but inability to micturate. There is a history of having missed two or three menstrual periods, and in the last few days increasing difficulty on micturition, developing into complete retention, this being followed by a steady dribbling of urine. A pyriform elastic swelling can be felt extending from the pelvis upwards, often as high as the umbilicus. The swelling, which is tender on pressure, lies so close to the pubes that the fingers can scarcely be inserted between them. On vaginal examination the cervix is found to be soft and lying high up behind the symphysis pubis. A soft, round, elastic swelling—the fundus of the gravid uterus, is felt in the pouch of Douglas. Catheterisation at once establishes a diagnosis of *retroverted gravid uterus with incontinence*.

Other conditions which lead to retention of urine with overflow are ovarian cysts impacted in the pelvis (rare), uterine fibroids similarly impacted, pelvic hæmatocele, and hæmatocolpos (also very rare). In all these cases the available pelvic space is occupied by the abnormal swelling so that the bladder is displaced up into the abdomen and the urethra is stretched. This stretching, when extreme, may lead to

retention of urine, but in the production of this symptom there is probably also a nervous element.

Exertion incontinence, in which there is escape of a small amount of urine on coughing, sneezing, or making muscular effort, is much more common. It is due to loss of support of the neck of the bladder and urethra, resulting in sacculation of the lower end of the vagina, the urethra rotating forwards under the pubic arch.

Another form of so-called incontinence is that in which the patient complains of an uncontrollable escape of urine. On enquiry it will be found that there is such urgent desire that micturition occurs before a convenience can be reached. The cause is a trigonitis, usually secondary to a chronic cervicitis, for the treatment of which see page 2463.

For cure of *exertion incontinence* see page 2393.

NOCTURNAL INCONTINENCE

This term is not strictly correct—it should be “nocturnal micturition.” The condition is most commonly seen in young children and in girls up to the age of twenty. It is essentially an aberration of the function of micturition, as there is seldom any actual lesion to be found in the bladder or urethra. Sometimes the condition defies all attempts at cure, and the state of the patient may be one of great distress.

Treatment. In the first place the urine should be tested, and, if acid, alkalis, such as sodium citrate 30–60 grs., should be given t.d.s. The irritability of the bladder can to some extent be reduced by the administration of belladonna or hyoscyamus, as these drugs have a paralysing effect on the nerve endings, both motor and sensory, in the bladder and urethra. In children belladonna is more effective, and is well tolerated. For children from 5–15 years of age 5 minims should at first be given, t.d.s., this being steadily increased to 20 minims t.d.s. in two weeks. Constant watch should be kept for dilatation of the pupils, dryness of the mouth and thirst, when further administration should cease until all such symptoms have subsided. Then small doses should be given, such as 5 minims t.d.s. Children stand belladonna very well, so that the dosage for a child and for an adult varies little. In older patients tincture of hyoscyamus appears to give better results. The dose should start at 30 minims t.d.s., being gradually increased to 60 minims. Frequently these patients

sleep badly and dream a great deal, and in such cases sodium bromide 10-20 grains t.d.s. is indicated. When quiet sleep is restored, usually after about two weeks, the dose should be gradually reduced until the drug is no longer required.

Sometimes it is found that the nocturnal emptying of the bladder takes place when the patient lies on her back. This can be prevented by the use of a belt, such as a folded towel, with a large knot tied over the centre of the back, which will cause discomfort when lying in the dorsal position.

Hydrostatic dilatation of the bladder is indicated in intractable cases.

CHAPTER IV

VAGINA

THE vagina is a comparatively new structure in animal phylogeny. It is developed as a downgrowth from the primitive Müllerian ducts after these structures have fused in their lower or caudal extremities to form the uterus.

The following conditions will be described :

- (A) Malformations.
- (B) Aberrations of function.
- (C) Injuries.
 - (1) Lacerations.
 - (2) Fistulæ.
 - (3) Acquired Atresia.
- (D) Inflammations.
- (E) Prolapse.
- (F) Cysts.
- (G) New Growths.

MALFORMATIONS

Persistent Cloaca is extremely rare, and is only seen in monsters.

Absence of Vagina. Complete absence is uncommon, and is usually associated with absence or under-development of the uterus. The ovaries are usually present and secondary sex characters are well developed. The cause is failure of the vaginal cord to develop or canalise.

Symptoms. Amenorrhœa, primary in type, is the one constant symptom. When the uterus is sufficiently developed for menstruation to take place there will be monthly menses, and possibly pelvic pain and malaise. Menstrual blood will accumulate, giving rise to hæmatometra and possibly hæmatosalpinx, and a hypogastric swelling may result. Absence of the vagina confines the patient to a celibate life, and if the

condition is not recognised before marriage much unhappiness is liable to follow. Absence of menstruation, however, usually leads to examination and discovery of the defect.

Signs. On examination, no vaginal opening will be found. The urethral meatus will be separated from the anus by a bridge of tissue. On digital investigation the rectum will be found to lie very close to the urethra and base of the bladder. The rudimentary or small uterus, if present, may be felt behind the bladder. If hæmatometra has developed, the distended uterus, varying in size with the amount of accumulated fluid, may be felt bimanually.

Treatment is required (1) for the relief of hæmatometra; (2) to make the patient nubile, should she especially desire it.

Both of the conditions may be remedied by forming a vagina (see page 2416).

Atresia of the Vagina. (1) Congenital. (2) Acquired.

Congenital Atresia is more common than absence of the vagina. It is due to incomplete canalisation of the vaginal cords which grow downwards from the lower ends of the Mullerian ducts. Although the lower half inch is the site most usually affected, occasionally the upper end or a small portion in the middle may be involved.

Hæmatometra, hæmatocolpos, and even hæmatosalpinx will ensue from the retention of the menses, and sexual intercourse will be impossible.

Hæmatocolpos, resulting from atresia, usually of the lower end of the vagina, has a characteristic history. A patient between the ages of 17 and 20 is examined because of amenorrhœa, usually associated with *molimina* (malaise, backache, or pain in the lower abdomen), occurring once a month.

A swelling (the distended vagina) may be felt in the hypogastrium and a small body (the uterus) on its upper aspect. Inspection of the vulva may reveal a tense bluish swelling bulging into the vulval cleft. The hymen may be seen stretched around its periphery (fig. 1155). On rectal examination the tense distended vagina will be felt lying in front.

Treatment. The septum is divided, and the vaginal contents are evacuated. The retained fluid is thick, viscid, and black, in consequence of changes that occur in the hæmoglobin. The strictest asepsis must be observed as this altered blood may

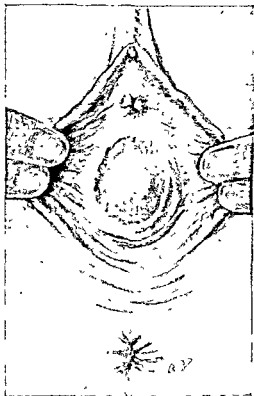


Fig. 1155.—ATRESIA OF THE LOWER END OF THE VAGINA. THE LOWER END OF THE VAGINA IS NOT OPEN, BEING OCCLUDED BY A THIN SEPTUM WHICH IS BULGING AS THE RESULT OF RETAINED MENSTRUAL FLUID. THE HYMEN LIES SUPERFICIAL TO THIS SEPTUM AND CAN BE SEEN AROUND ITS PERIPHERY.

easily become infected, producing fatal results. This is especially the case if there is distension of the uterus with menstrual blood—hæmatometra, or of the tubes—hæmotocolpos. In the latter condition there is the superadded danger of rupture of the distended tubes, with resulting hæmorrhage.

Imperforate Hymen is rare, and will produce conditions identical with those described under atresia.

Acquired Atresia presents many features in common with the congenital type.

Septate Vagina results from failure of the two downgrowths from the Müllerian ducts to fuse completely. One portion may be much smaller than the other and thus escape detection. Both sides may function in parturition if there is a double uterus, each half of which is sufficiently developed. The lower end of one side may remain occluded, menstrual fluid accumulating and causing hæmatocolpos, hæmatometra, or even hæmatosalpinx on the affected side.

The septum must be excised if causing dyspareunia. Retention of menses in an occluded half of the vagina should be treated on the same lines as retention due to atresia.

ABERRATIONS OF FUNCTION

Dyspareunia is pain on sexual intercourse or attempted intercourse.

- Causes* : (1) Organic lesions, or
(2) Nervous conditions.

Organic Lesions. These may affect (a) the external, or (b) the internal genitalia.

Conditions affecting the *external* genitalia are rigid hymen, very tender partially lacerated hymen, painful fissures of the hymen and vaginal entrance, vulval inflammations and ulcers, urethral caruncle, vascular degeneration of the urethra and vaginal entrance, disproportion between the male organ and the vagina—due to congenitally small vagina, kraurosis or atrophy at the menopause, and anal conditions such as fissures or thrombosed external hæmorrhoids.

Conditions affecting the *internal* genitalia include prolapsed ovaries and salpingo-oöphoritis.

Nervous Conditions. The commonest cause is that in which, through lack of desire or as the result of fear, there is dryness of the vulva and vaginal entrance. In ordinary circumstances these parts are freely lubricated with mucous secretion. Nervous fatigue, poor general health, and neurasthenia are occasionally causative factors.

Clinical Types : (i) Dyspareunia frequently dates from the start of marital relations. The usual condition is partial or complete laceration of the hymen, with resulting infection and the formation of extremely tender fissures.

(ii) Dyspareunia which dates from a recent confinement involving perineal lacerations, either not completely healed or with painful tender scar formation.

(iii) Symptoms of backache or lower abdominal pain, occasionally attended by nausea and vomiting. Menorrhagia, pelvic pain, and "bearing down" sensations are usually present, indicating pelvic inflammation. Tender swollen tubes, prolapsed ovaries or a retroverted uterus can often be detected on examination.

(iv) Older patients, near the menopause, with atrophied vagina, vascular degeneration, urethral caruncle, and dryness of the vulva and vagina.

(v) The nervous type of patient, frequently thin and anæmic, who may have marked tenderness in the pelvis without evidence of any lesion to account for it.

Treatment. Much unhappiness and worry, and occasionally marital disasters, have resulted from dyspareunia. Search must be made for any local cause and appropriate treatment advised. In cases of painful fissures and ulcers of the hymen and vulva, coitus is interdicted for two weeks. Hot hip baths or fomentations to the vulva will quickly clear up the local inflammation. The remnants of the hymen should then be excised. Rigid hymen or small vaginal inlet is best treated by excision of the hymen and enlargement of the vaginal entrance (see page 2418). Vascular degeneration and atrophy of the vagina are often troublesome conditions, requiring prolonged treatment or even operation (see page 2210).

Nervous Conditions. Simple dryness of the vulva can very often be treated effectually by the use of a suitable lubricant. A sedative mixture containing bromides and valerian is also prescribed.

Vaginismus is a condition in which, upon any attempt at coitus or vaginal examination, there are powerful, spasmodic, and sometimes painful contractions of the levatores ani muscles, associated in varying degrees with contraction of the glutei, extensors and adductors of the thighs, and occasionally with opisthotonos. The contraction of the

levator ani muscles may be so powerful as to close the vaginal entrance completely. It is usually a primary condition, being present from the first sexual act, but it may appear for the first time after several years of marital life and has been known to arise after childbirth. Pregnancy may occur in spite of the condition, for if spermatozoa are deposited on a moist part of the vulva, they may migrate upwards through the genital passages and fertilise an ovum. The condition may not be cured by parturition.

Causes of Vaginismus.

(1) *Local* conditions, such as lesions of the hymen and vaginal entrance, are responsible for the majority of cases. The hymen is occasionally tough and unyielding; more frequently it is partially or completely torn, the resulting lacerations becoming infected, and giving rise to painful fissures and tender swollen tags. On inspection, the vaginal entrance is seen to be red, with swollen hymenal remnants and one or more tender fissures. Often the gonococcus is the infecting agent, but occasionally the streptococcus or staphylococcus. Infection of the orifice of Bartholin's ducts may produce tenderness. Urethral caruncle may be a cause of vaginismus, but is rarely seen in young patients. Anal fissure or inflamed external hæmorrhoids may also be aggravating factors.

(2) *Functional* causes account for a few cases. It is possible that hysteria, also general repugnance, sexual frigidity, or fear as the result of a previous painful experience, may account for some cases.

Treatment. (1) *A Rigid Hymen*, or one partially lacerated, should be excised, the vaginal entrance fully stretched, and perineotomy performed (see page 2418).

(2) *Lacerated and Inflamed Hymen.* The essentials of treatment are rest and heat. Attempts at coitus should be interdicted for at least two weeks. Heat is best applied by hot hip baths, and in the early stages by fomentations. When the inflammation has subsided, vaginal tags should be excised and the vaginal entrance stretched.

(3) *Functional Causes.* There are few cases of this type which will not yield to treatment. Tenderness of the hymen is undoubtedly responsible for a number of cases, even when it may appear normal. The operative treatment consists of excision of the hymen and Fenton's operation.

Vaginal dilators inserted for a few hours daily will be helpful. Anodyne ointments are of little value.

"When the abdominal muscles are contracted as in straining down, the perineal muscles are reflexly relaxed. Much relief can be obtained if the patient be instructed to 'bear down' during coitus." (Bourne, *Synop. of Midwif. and Gynæ.*, p. 416, Wright, 1932.)

Results. When there are organic causes and these are removed, cure will immediately result in almost every case. A small percentage of functional cases will remain unrelieved, even after parturition.

INJURIES

- (1) Lacerations.
- (2) Fistulæ.
- (3) Acquired Atresia.

(1) *Lacerations.* These are almost invariably due to labour. Very rarely they may be caused by disproportion between the vagina and penis, associated with violence. The usual sites of laceration are (a) the posterior wall at its lower end, or (b) the vaginal vault.

(a) *Lacerations of the lower end of the Vagina.* These are generally associated with some degree of rupture of the perineal body. It is, therefore, of advantage to consider lacerations of the perineum and lower part of the vagina together.

These injuries are exceedingly common. Primiparæ seldom escape a perineal tear of some degree.

Varieties of Rupture. These may be divided into the following groups according to their extent :

First degree. The fourchette is torn and the skin of the lower inch of the posterior wall of the vagina covering the anterior part of the perineal body is ruptured, usually to the depth of half an inch.

Second degree. The perineal body is split, often down to the sphincter ani and the posterior wall of the vagina is torn for a varying distance. Frequently the laceration is Y-shaped, extending a short way up each postero-lateral sulcus. Occasionally the tear extends upwards on one side only. The levatores ani muscles are often injured or attenuated from excessive stretching. The skin of the perineum is

torn backwards for some distance. Sometimes, however, it remains intact while the perineal body is extensively split, and lacerations extend up the vaginal wall in one or both lateral sulci. This latter type of laceration may easily escape notice unless the posterior wall of the vagina is examined both by palpation and inspection.

Third degree. The essential characteristics of third degree lacerations are: Rupture of the sphincter ani and splitting of the anterior wall of the rectum for some distance. The rectum and lower part of the vagina are converted into a cavity resembling the primitive cloaca. Except for this additional extension into the rectum, the structures torn are the same as those mentioned under "Second degree."

Central Rupture. This is an extremely rare injury, in which the lower part of the vagina is torn and the perineum ruptured except at its anterior edge. On exceptional occasions the foetus may be born through this rent and the bridge of tissue remain intact, but more commonly these tissues give way and a second degree tear results.

Causes. Conditions which tend to cause these lacerations are too excessive and too rapid stretching of the vaginal outlet.

Excessive stretching may be due to a very large foetal head, persistent occipito-posterior position, in which the fronto-occipital diameter passes through the vaginal outlet, poor flexion, or too early extension of the head in the occipito-anterior position.

Too rapid stretching, as by forceps extraction or precipitate labour, is more liable to produce a tear than incomplete flexion of the foetal head.

Prevention. When possible, forward rotation of the occiput must be ensured. Too early extension is prevented by pushing the foetal head backwards until the occipito-cervical angle pivots under the pubic arch; thus the sub-occipito-frontal and sub-occipito-mental diameters instead of the occipito-frontal and occipito-mental diameters pass through the outlet. Too rapid delivery is prevented by deepening anaesthesia and delivering the head between the pains. Extensive third degree tear into the rectum can be prevented by performing episiotomy when it is seen that laceration with risk of extension into the rectum is unavoidable.

Results of Perineal Rupture. These injuries must be regarded as serious, primarily on account of the risk of sepsis. The wound may

become infected, with risk of the infection spreading to the uterus. Later results are due to the tearing of the perineal body and levatores ani muscles. Consequently the supporting function of the pelvic diaphragm is impaired or lost, thus predisposing to cystocele, rectocele, and prolapse of the vaginal vault and uterus.

A recto-vaginal fistula or loss of rectal control may result from failure of a complete rupture to unite after being sutured.

Treatment consists of suture of the lacerations. This may be (i) immediate ; (ii) secondary ; or (iii) late.

(i) *Immediate suture.*

For Incomplete Rupture. After delivery of the placenta the vagina should be examined to determine the exact extent of the lacerations. The wound is cleansed and swabbed with an antiseptic, such as tincture of iodine ($2\frac{1}{2}$ per cent in spirit). The vaginal wall is sutured with plain catgut after the perineal body has been restored, and the divided levatores ani muscles approximated with plain catgut stitches. These should be passed *deeply*, entering the perineal body about half an inch from the end of the wound and emerging on the opposite side at the same distance from the edge. As a rule three interrupted stitches are required. The object of these sutures is to afford approximation without tension ; on no account should they be tied tightly, as subsequent œdema is liable to produce strangulation and cause the stitches to cut out. The skin is sutured with interrupted silk-worm-gut sutures.

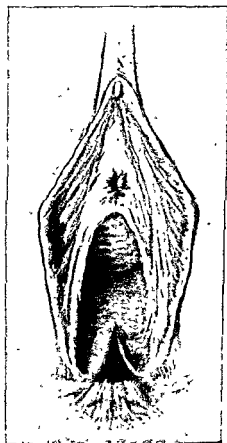


Fig. 1156.—COMPLETE LACERATION OF THE PERINEUM.

For Complete Rupture (fig. 1156). The first step here is careful suture of the rectal mucosa and sphincter ani muscles with interrupted plain catgut. The remainder of the operation, viz., suture of the vaginal laceration, stitching of the split perineal body and levatores ani muscles, and suture of the skin, is performed as in incomplete rupture.

After-Treatment It is important to prevent contamination of the wound as far as possible and to keep the sutured parts scrupulously clean. An ointment consisting of chlorethane 5 per cent, carbolic acid 0.25 per cent, in equal parts of lanolin and vaseline, is smeared over the wound. This has the added action of a local anæsthetic. After micturition or evacuation of the bowels, the wound is swabbed with carbolic acid lotion (1 in 40) or 2½ per cent dettol. For the first three days the bowels are opened with enemata. In cases of complete laceration the bowels are confined for three days. Castor oil is then given. As soon as griping pains are felt, an enema of olive oil is run very slowly high into the rectum. Afterwards the bowels are kept fairly free for at least another week or ten days.

(ii) *Secondary suture.* If the stitches cut out after primary suture, all the remaining stitches should be removed. Sloughing fragments are excised with scissors, the wound is cleansed by painting with tincture of iodine, and suture is repeated.

(iii) *Late suture.* Where secondary suture has failed, no further attempt should be made to repair the damage, but the wound should be kept clean and allowed to heal by granulation. Colpo-perineorrhaphy is performed six months after healing is complete.

(b) *Lacerations of the Vaginal Vault.* The commonest lacerations of the vaginal vault are extensions of cervical tears, which may be unilateral or bilateral.

Results. There are two important sequelæ, viz., sepsis and hæmorrhage.

Sepsis. These wounds are liable to become invaded by organisms, especially the streptococcus, with spread of infection to the cellular tissue of the broad ligament (parametritis), to the uterus, Fallopian tubes, pelvic peritoneum, and less frequently, to the blood stream (septicæmia).

Hæmorrhage may be primary or secondary. *Primary hæmorrhage* is the result of tearing of some of the larger branches of the uterine

artery. Persistent bleeding will result, even when the uterus is firmly contracted.

Secondary hæmorrhage, which is rare, occurs during the puerperium and is always due to sepsis.

Treatment. These lacerations require suture with catgut. Brisk hæmorrhage occurring after labour with the uterus firmly contracted calls for inspection of the cervix and vaginal vault. Strict antiseptic precautions must be observed. The cervix is exposed with a speculum, the two lips are pulled down with vulsella and deep stitches of chromic catgut are passed. This will arrest hæmorrhage and approximate the torn edges.

Secondary hæmorrhage should be controlled with deep catgut sutures.

Horizontal rupture of the vault, involving the floor of the bladder, is a rare accident, occurring in some cases of forceps delivery when the bladder has not first been emptied.

Symptoms. Incontinence of urine will be present from the time of delivery. On inspection the laceration in the anterior part of the vault can be seen.

Treatment. Immediate suture should be performed followed by antiseptic douching. A catheter is tied into the bladder for a week, and urinary antiseptics such as urotropine, 10 grs., or acid sodium phosphate, 30 grs. t.d.s., are given.

Results of Lacerations of the Vault. Lateral lacerations opening up the base of the broad ligament are liable to be followed by painful, tender scars.

(2) *Fistulæ of the Vagina.* These are communications between the vagina and adjacent viscera, and may be vesico-vaginal, recto-vaginal, or uretero-vaginal.

Vesico-Vaginal Fistulæ. Causes : (a) Injuries.

(b) Burns.

(c) Carcinoma of the cervix.

Injuries. Sloughing of the anterior vaginal wall and base of the bladder may follow prolonged pressure between the foetal head and the pubic bones during labour. The base of the bladder is occasionally torn

during difficult forceps delivery when previous catheterisation has been omitted. The bladder may also be injured during hysterectomy or vaginal repair.

Burns may occur during the radium treatment of cervical carcinoma.

Carcinoma of the cervix will invade the base of the bladder at a late stage, and may give rise to vesico-vaginal fistula.

Symptoms. Continual escape of urine from the vagina is the outstanding symptom. When the urine becomes infected, a foul ammoniacal odour results, followed by irritation and soreness of the vulva.

Signs. On vaginal inspection the fistula can occasionally be seen ; sometimes the aperture can be felt with the finger. If coloured fluid, such as a solution of methylene blue, is injected into the bladder, it can be seen escaping from the opening. Cystoscopic examination should always be undertaken in these cases to determine the exact site of the fistula and to exclude the presence of a uretero-vaginal fistula.

Results. Fistulæ which are due to carcinoma gradually increase in size. Small fistulæ, following operation or laceration of the vaginal vault, occasionally close spontaneously. Usually, however, these fistulæ are permanent, becoming increasingly indurated, and often defy all attempts at cure. There are two conditions which make closure of the fistula difficult : pressure of urine which tears apart the healing edges, and close proximity of the two epithelial surfaces of the bladder and the vagina. The depth of tissue between the bladder and the vagina is very small, with the result that the epithelium from the two surfaces rapidly proliferates and meets around the margin of the opening. Further healing is thus brought to a standstill and the fistula is permanently established.

Treatment. Minute fistulæ can occasionally be made to close by cauterising the epithelium which has grown into the opening, either with silver nitrate or with the actual cautery. Larger fistulæ require special operations. These may be carried out by the vaginal or the abdominal route (see page 2413).

Recto-Vaginal Fistulæ. Causes. Recto-vaginal fistulæ are usually due to some part of the suture line breaking down after repair of a complete perineal laceration resulting from labour. Very occasionally carcinoma of the vagina, either as a primary growth or secondary to

carcinoma of the cervix, ulcerates into the rectum, resulting in a fistula.

Symptoms. Flatus and fæculent fluid escape via the vagina. Very rarely is the opening large enough for the passage of solid fæces. On vaginal examination the opening may be felt and occasionally seen about an inch from the lower edge on the posterior vaginal wall. A probe can be passed into the opening from the vaginal aspect and brought out through the rectum.

Treatment (see page 2412).

Uretero-Vaginal Fistulæ are extremely rare, apart from operative injury.

Symptoms. The characteristic symptom is constant escape of urine from the vagina, while at the same time the bladder fills and empties in a normal manner.

Cystoscopic examination will show that only one ureter is emptying into the bladder.

Treatment. If the injury inflicted on the ureter at operation is recognised at the time, an attempt should be made to implant the lower end of the cut ureter into the fundus of the bladder. When this is impossible, the ureter may be crushed and tied in hope of producing atrophy of the kidney. When a uretero-vaginal fistula is not recognised until some time after operation, the kidney on the injured side should be removed, as gross infection almost invariably supervenes. Before tying the ureter or removing the kidney, it is most important to ascertain the presence of a healthy functioning kidney on the opposite side.

(3) *Acquired Atresia.* This is a very rare condition in which adhesion of the opposing surfaces has followed sloughing such as may be caused by suppurating vaginitis or scalding from too hot a douche. Granular vaginitis complicating acute exanthemata is sometimes accountable for the condition when occurring in children.

Results. Menses may be retained and sexual intercourse be impossible.

Treatment. Operative measures are indicated for the relief of the retention of menses and restoration of capacity for coitus. Great

difficulty may be encountered, as it will be necessary not only to make a passage, but also to line it with epithelium. Where all restorative efforts fail, the menstruating uterus and mucus-secreting cervix should be removed.

Partial adherence of the vaginal walls sometimes follows operations in which, as the result of the use of irritating antiseptics, desquamation of the epithelium has been followed by the adhesion of opposing surfaces. Occasionally the suture lines of an anterior and posterior colporrhaphy become adherent and may interfere with coitus. These adhesions can be prevented by the passage of a finger two or three times a week for two weeks after operation.

INFLAMMATIONS

Vaginitis may be due to specific or non-specific organisms. The condition is usually chronic, seldom acute. It is not often seen during active sexual life, because the vagina is lined with stratified epithelium which is free from glands and highly resistant to microbic invasion. Further, the presence of Döderlein's bacillus, rendering the vaginal secretions acid, is a great deterrent to bacterial activity.

Clinical Varieties. (1) *Vaginitis of Children.* This is usually a vulvovaginitis, and may occur at any age from birth to puberty.

Causes. Infection with the gonococcus is probably the commonest cause, but thread worms or the bacillus coli may occasionally be responsible.

Symptoms. The chief symptoms are irritation, vaginal discharge, and scalding pain on micturition. On inspection, the vulva is red and frequently abraded from scratching. The hymen and the lower part of the vagina are red and covered with a thin discharge. In the early stages of gonococcal vaginitis the gonococcus may be identified in smears.

Treatment. Search must be made for the presence of thread worms, and if these are found or suspected, quassia should be administered. A convenient method is to give it in the form of a suppository, such as extract of quassia, $\frac{1}{2}$ gr. in a gelatine base. This suppository is excellent for infants; for older children the strength should be increased. One suppository should be inserted daily for three or four days or until the worms have disappeared. The urine should always be rendered

alkaline by administration of sodium citrate, 5-30 grs. t.d.s., according to age.

In gonorrhœal cases the vulva should be swabbed twice daily with zinc sulphate lotion (1 drachm to the pint) at 110° F., argyrol 15 per cent, or protargol 10 per cent, 3 cc. being instilled into the vagina daily. This is best accomplished with a Record syringe, fitted with a small thin rubber nozzle about an inch long.

Results. If left untreated, the condition persists indefinitely. It is important to remember that in institutions gonorrhœal vulvo-vaginitis has a marked tendency to spread among young children. Infected cases should be segregated and all toilet articles kept apart.

(2) *Vaginitis during Sexual Life.* Gonorrhœa rarely attacks the vagina except during pregnancy. The mucous membrane then becomes markedly inflamed, covered with thin pus, and dotted with numerous red spots. Occasionally there is profuse growth of gonorrhœal warts over the walls, including the vault and even covering the cervix.

Treatment. (a) *Pessaries:* Argyrol 15 per cent in oil of theobroma, one being inserted high into the vaginal vault every night for ten nights.

(b) *Douches:* Zinc chloride (1 in 2000), three quarts at 115°-118° F., night and morning for two weeks. At the same time the infection in the cervix, urethra, and Bartholin's glands must be treated. Warts must be removed with a sharp curette and the vagina lightly packed with dry gauze for 12 hours.

Suppurative or Puerperal Vaginitis. This is due to extensive bruising and laceration during difficult labour. The lower end of the vaginal wall and perineum are the most common sites of laceration, but occasionally the vault, including the cervix, may be affected. Suppuration follows, due to invasion with the streptococcus, staphylococcus, and occasionally bacillus pyocyaneus. The uterus is liable to be infected at the same time or subsequently. Large areas of the vagina may slough and healing may be attended by extensive cicatrisation. Considerable subsequent narrowing of the vagina is almost invariable, and sometimes there is complete atresia.

Treatment. The patient should be kept in the Fowler position to promote drainage. Concentrated saline douches, sodium chloride 1 oz.

to the quart at 115°-118° F., is given t.d.s. If there are signs of sloughing, $\frac{1}{2}$ oz. of glycerine should be instilled high into the vagina three or four times daily.

An attempt should be made to prevent subsequent stenosis by the use of graduated vaginal dilators. Some form of plastic operation may be necessary to restore vaginal patency. When the whole vagina sloughs, complete atresia will result and treatment will be necessary on similar lines to these outlined for congenital atresia.

(3) *Senile Vaginitis*. This is a chronic inflammation due to septic infection occurring after the menopause. The mucosa is thin and atrophic and the protective acid secretion is absent.

Pathology. There is desquamation of the vaginal epithelium in wide patches and isolated spots. Small islands of granulation tissue are formed under the attenuated epithelium and in the denuded areas. There is free exudation of serum and leucocytes, giving rise to a purulent discharge which occasionally contains gas-bubbles.

The vaginal vault is the part chiefly affected. Usually, however, the cervix, especially round the external os, the vulva and urethral meatus, shows scattered red patches. The infection often spreads upwards to the uterine cavity, causing senile endometritis. Occasionally it ascends to the bladder, giving rise to urethritis and cystitis.

Symptoms. Free purulent discharge, often offensive and occasionally blood-stained, is always present. When the vulva and urethra are inflamed, there will be soreness and pain on walking or sitting, and scalding pain on micturition.

Signs. The vulva and urethral meatus are red and covered with purulent discharge which can be seen escaping from the vagina. The vaginal mucosa, especially in the vault and over the cervix, is covered with numerous bright red spots which bleed when rubbed with a swab or with the finger. There is sometimes superficial ulceration on the posterior part of the vaginal vault. The whole vagina is covered with thin pus which may also be seen escaping from the external os.

Treatment. The condition usually yields to treatment, except where there is superadded senile endometritis or carcinoma of the body of the uterus. Pessaries (argyrol 20 per cent, or protargol 15 per cent, in oil of theobroma, inserted high into the vagina nightly for two weeks), douches (zinc chloride, 1 in 2000, using 3 quarts at 112°-115° F.,

night and morning), and œstrin (250,000 to 500,000 international units weekly) are employed for the cure of this condition.

Results. If left untreated the disease runs a chronic course and is liable to be followed by vaginal contractions, adhesions, and possibly atresia. When treated on the lines indicated there is usually rapid recovery, but some degree of contraction may result.

PROLAPSE

Prolapse is the term used to signify any descent or downward displacement of the vaginal walls or uterus. It is best to discuss vaginal and uterine prolapse together, as descent of the uterus is always associated with descent of the vagina, and all forms of vaginal prolapse tend eventually to produce some degree of uterine prolapse.

Causes. (1) Predisposing: (a) acquired; (b) congenital.

(2) Exciting.

(1) *Predisposing Causes.* (a) *Acquired.* Injury to the pelvic floor or uterine supports during childbirth is the predominant cause of prolapse. These injuries may occur as:

- (i) Laceration of the perineal body and resulting separation of the anterior margins of the levatores ani muscles.
- (ii) Laceration or stretching and attenuation of the anterior portions of the levatores ani muscles.
- (iii) Stretching of the transverse cervical (cervico-pelvic) ligaments, which are the main supports of the uterus and vaginal vault.
- (iv) Stretching or attenuation of the utero-pubic fascia, which supports the base of the bladder.

(b) *Congenital.* Weakness of the chief supports of the uterus and vaginal vault, such as the transverse cervical ligament, is a rare condition. As a result the uterus descends into the vagina in varying degrees, even amounting to complete procidentia. It may occur in nulliparæ with no history of perineal injury.

(2) *The Exciting Cause* is intra-abdominal pressure which exerts a downward thrust. Increase of pressure, such as that due to heavy laborious work, chronic constipation, asthma, increase of

intra-abdominal fat, large abdominal tumours, or ascites, greatly adds to the strain on the uterine supports and pelvic floor.

- Degrees of Prolapse.* 1st. The uterus has descended but remains within the vaginal canal.
- 2nd. The cervix protrudes from the vaginal entrance.
- 3rd. Also known as procidentia. The uterus lies wholly outside the body, enfolded by the completely everted vagina (fig. 1157).

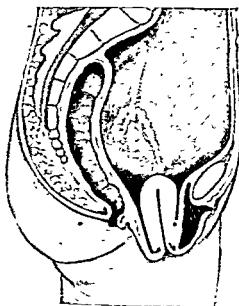


Fig. 1157.—COMPLETE PROCIDENTIA, OR THIRD DEGREE PROLAPSE.

Varieties. (1) *Vagino-Uterine Prolapse.* This begins with descent of the vaginal wall, such as in cystocele, rectocele, or hernia of the pouch of Douglas, and may be followed later by prolapse of the uterus.

(2) *Utero-Vaginal Prolapse.* The uterus descends first into the vaginal vault, gradually inverting and dragging down the vaginal walls.

Vagino-Uterine Prolapse. This is the commoner form and its mechanism may be described as follows:

The vaginal outlet is enlarged owing to rupture of the perineal body and laceration, stretching or separation of the levatores ani muscles.

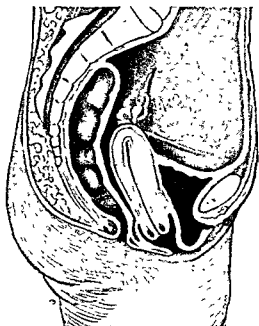


Fig. 1153.—RETROVERTED UTERUS WITH ELONGATED SUPRA VAGINAL CERVIX AND CYSTOCELE.

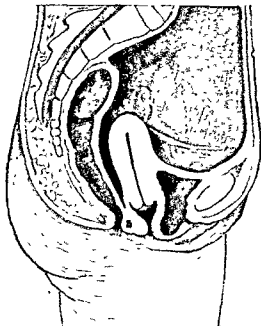


Fig. 1159.—RETROVERTED UTERUS, FIRST DEGREE PROLAPSE WITH CYSTOCELE.

Normally, during exertion when the abdominal muscles are tightened, the levatores ani contract, closing the vaginal outlet and forming a firm diaphragm. As the result of the loss of this support, the anterior vaginal wall bulges downwards, forming a cystocele, which in turn exerts a downward pull on the cervix. This may have two effects:

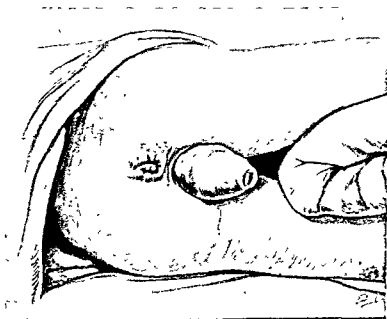


Fig. 1160.—COMPLETE PROCIDENTIA, OR THIRD DEGREE PROLAPSE. THE VAGINA HAS BEEN TURNED COMPLETELY INSIDE OUT EXCEPT FOR THE LAST HALF INCH OF THE POSTERIOR VAGINAL WALL.

(a) elongation of the supra-vaginal part (when the transverse cervical ligaments are strong) (fig. 1158); or (b) the dragging downwards of the uterus and the vaginal vault (fig. 1159). The descent of the uterus is brought about first by retroversion as the result of the pull of the cystocele, and secondly by gradual downward dragging along the axis of the pelvis. As the uterus and vaginal vaults descend, the vaginal walls are relaxed and protrude from the vulva, as an increasing cystocele in front and a rectocele behind. This process may be arrested at any

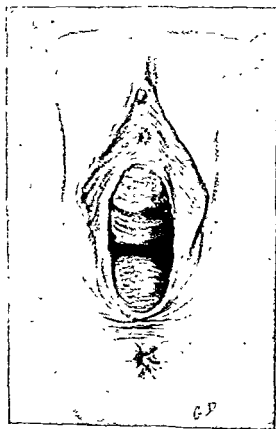


Fig. 1161.—CYSTOCELE AND RECTOCELE OF THE VAGINA.

point, with the result that there may be a cystocele only, or a cystocele and rectocele, or it may continue until the vagina is turned completely inside out and lies wholly outside the body (procidentia) (fig. 1160).

Cystocele. This is the most usual form of vaginal prolapse and one of the most common of gynaecological affections. It is due to laceration of the perineal body and separation, laceration or attenuation of the levatores ani muscles. As the result of intra-abdominal

pressure, the bladder bulges downwards and backwards, carrying the anterior vaginal wall through the vulval cleft. The first part to protrude is that immediately above the urethral orifice. The anterior vaginal wall becomes stretched, losing its rugæ, increasing in length and width, and later becoming thickened and voluminous. Two fairly well defined sacculations, a lower and an upper (fig. 1161), separated by a shallow transverse sulcus, may develop at a later stage. The double sacculatation is due to a condensation of the subvesical fascia forming a firm transverse band underlying the sulcus.

The cystocele may remain at this stage, but there is a tendency for it to increase in size and to pull the cervix and vaginal vault downwards.

Rectocele. This is a descent of the posterior wall of the vagina and the anterior wall of the rectum. It is much less common than cystocele, in association with which it frequently occurs. On occasions it may be the only form of vaginal prolapse.

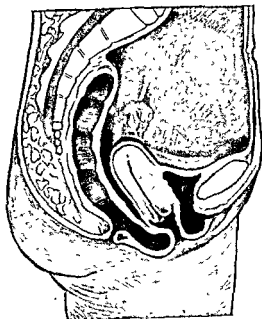


Fig. 1162.—RECTOCELE AND CYSTOCELE, ASSOCIATED WITH RETROVERSION AND DESCENT OF THE UTERUS.

The chief predisposing cause is laceration of the perineal body which directly supports the vaginal canal in this situation. On straining or exertion, the posterior wall bulges forwards immediately above the vaginal outlet. The lower part of the vagina, which in the absence of the perineal body is attached to the sphincter ani, does not descend, but the rectocele protrudes as a rounded swelling (fig. 1162).

Hernia of the Pouch of Douglas. This is a downward protrusion of the posterior part of the vaginal vault. It is a rare occurrence, and may be due to stretching of this part of the vagina during labour, or result from congenital weakness of the vault. Usually the protrusion is small, but it occasionally reaches the vulva. The protruding part is composed of the vaginal wall and peritoneum of the pouch of Douglas and may contain coils of intestine.

The anatomical relations of this type of hernia are: the cervix uteri in front, the rectum behind, and on each side the utero-sacral ligaments.

Results. The hernial protrusion increases in size, exerting a downward pull upon the cervix, and tending to retrovert the uterus and to drag it downwards in the axis of the vagina.

Treatment (see pages 2422 and 2541).

Utero-Vaginal Prolapse is a rare variety in which the uterus descends first into the vaginal vault, gradually dragging the vagina downwards, causing prolapse of varying degree and tending ultimately to complete procidentia.

Procidentia or Third Degree Prolapse of the Uterus. Procidentia, with a few exceptions, is a sequel of vaginal prolapse resulting from injuries during labour. A small percentage of cases are due to congenital weakness of the transverse cervical ligaments.

The vagina is turned completely inside out with the exception of the last inch of the posterior wall, which remains attached to the sphincter ani (see figs. 1157 and 1158). The apex is formed by the cervix and the external os. The everted vagina enfolds the following structures in order from before backwards: The urethra, and at a lower level part of the bladder, the utero-vesical pouch of peritoneum, the uterus, and the pouch of Douglas (possibly containing coils of small intestine). The Fallopian tubes lie parallel and vertical. The ovaries are prolapsed in varying degree, causing elongation of the ovario-pelvic ligaments. The supra-vaginal cervix is always elongated, having been stretched by the downward pull of the prolapsing vagina. The uterine and cervical cavities may be as much as six inches in length. The exposed cervix and the vaginal walls are liable to become ulcerated from friction against clothing. The epithelium is greatly thickened, keratinised, and occasionally scaly.

Symptoms of Prolapse. In the early stages of prolapse the more usual symptoms are pain, described as a "bearing down" feeling or a sensation of weight in the pelvis, and an ill-defined sense of discomfort in the lower abdomen. All these are increased on walking or standing and are relieved by lying down. In the early stages there are usually no bladder symptoms, but when these are present, there may be incontinence of urine on coughing or straining, or frequency of micturition. Occasionally there is great difficulty in emptying the bladder unless the prolapsed part is first pressed upwards. Leucorrhœa is generally present as the result of ulceration (traumatic) or chronic cervicitis. In the later stages pain usually disappears. Bladder symptoms and discharge are the same as in the early stages. The vulval swelling increases in size and protrudes on straining or standing. In complete procidentia there is seldom any pain. Urinary symptoms increase, chiefly as the result of difficulty in emptying the bladder. This is due to inability to exert pressure upon that viscus during the process of micturition, and straining efforts merely increase the bulging of the partially extruded bladder. Frequency of micturition is a constant late symptom, owing to the presence of a certain amount of residual urine which predisposes to cystitis.

Physical Signs. The vaginal entrance appears large and relaxed, and the perineum is often split down to the sphincter ani. Occasionally, however, the perineal skin may appear normal, but a finger passed into the entrance will feel the lower part of the vagina lying directly upon the anal canal with no thickness of intervening tissue. If the posterior edge of the vaginal entrance is drawn backwards and the patient strains or makes a "bearing down" effort, the anterior vaginal wall bulges downwards and backwards; but on relaxation it tends to return to a more or less normal position. The part of the vagina immediately above the urethra usually remains sacculated. The posterior vaginal wall above the finger frequently bulges downwards and forwards and is somewhat increased on straining. In more advanced cases the cervix and the vaginal vault descend in varying degree on bearing down. Relaxation of the levatores ani muscles can be tested by pulling backwards on the posterior edge of the vaginal entrance and then passing a finger into the vagina. Normally the edge of these muscles can be felt as a distinct ridge on each side about an inch above the entrance, running at right angles to the lower part of the lateral vaginal wall. When the muscles are lacerated, stretched, or widely separated, this ridge cannot be felt, or it may be present to some degree on one side only.

Differential Diagnosis. Prolapse is easily recognised. A sound passed into the bladder enters the bulging portion and can be felt just beneath the vaginal wall. When a rectocele is present, a finger passed per rectum enters the posterior protrusion. The condition must be distinguished from :

(1) *Cyst of the anterior vaginal wall.* This forms an oval swelling which protrudes through the vaginal orifice, and can be distinguished from a cystocele by passing a bladder sound, which, in the latter condition, is felt close beneath the vaginal wall. When a cyst is present, the tense elastic wall can be felt between the finger and the sound.

(2) *Congenital hypertrophic elongation of the cervix.* In this condition the vaginal portion of the cervix is enlarged and lengthened, occasionally to the extent of three inches, and the external os may even protrude through the vaginal entrance. It may simulate the utero-vaginal type of prolapse, but cannot be pushed upwards into the pelvis. The vaginal fornices are at their normal distance from the vulva, i.e. about three inches. When the anterior fornix is pushed high up, the elongated cervix can be felt lying in the vaginal cavity. This is a useful test as there is often a certain amount of prolapse associated with congenital elongation.

Treatment of Prolapse.

- (1) Preventive.
- (2) Palliative.
- (3) Operative.

Preventive Treatment. This applies to a small number of cases seen early after labour. There are usually symptoms of weight and "bearing down" in the pelvis, and aching in the perineum or sacral region. On examination the levatores ani muscles are felt to be relaxed, causing bulging of the perineum and peri-anal regions on straining. There is no descent of the cervix, vaginal vault or vaginal walls. There may, however, be retroversion of the uterus. The patient is kept in bed for three or four weeks. Tonics and massage are given. Copious hot douches are administered twice daily to promote involution of the pelvic tissues. When the uterus is retroverted, the fundus should be restored to its normal position by manipulation, employing general

anæsthesia if necessary. A Hodge pessary is inserted for 5-6 weeks to maintain the anteverted position.

Palliative treatment is afforded by means of mechanical supports such as pessaries, e.g. cradle, ring, cup and stem (Napier's), or ball. Pessaries when used as described above may prevent prolapse after confinement but never effect a cure.

Cradle Pessary (Hodge) (fig. 1163). This is rectangular and double curved. Its chief use is to maintain the uterus in ante flexion after its

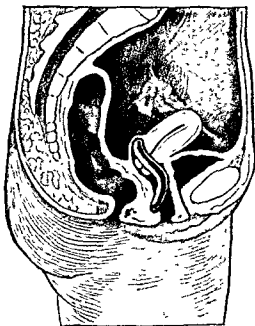


Fig. 1163.—UTERUS ANTEVERTED AND HODGE PESSARY IN PLACE.

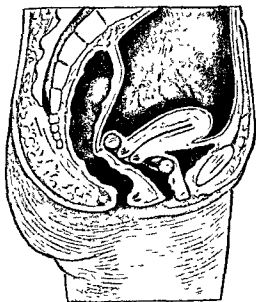


Fig. 1164.—UTERUS FORWARD IN NORMAL POSITION AND LARGE RING PESSARY INSERTED.

reposition by manipulation. It is sometimes used in the early stages of utero-vaginal prolapse in nulliparæ where the uterus is vertical or retroverted, and sometimes for the relief of cystocele; for this latter purpose modifications have been devised, such as Graily Hewitt's cradle which carries a thick forward projection to press the anterior fornix forwards and upwards.

Ring Pessaries (fig. 1164). These are of the watch-spring fluid type, or of the hard vulcanite type.

The watch-spring fluid type is a hollow rubber ring, containing several coils of watch-spring in fluid. The spring gives elastic firmness, whilst the rubber cover and fluid make the ring soft and somewhat plastic. It is made in twelve sizes, ranging in diameter from 2 to 3½

inches. The sizes most commonly used are from $2\frac{3}{4}$ to 3 inches. This type of ring is the one most generally employed. It is suitable for vagino-uterine prolapse of the first degree, when the cystocele is not very large and when the vaginal entrance is sufficiently taut to prevent its being extruded.

The hard vulcanite type is occasionally used for elderly women where there is a very relaxed vaginal orifice and inability to retain a flexible rubber ring. It is hard and unyielding and therefore liable to cause ulceration.

Cup and Stem Pessary (Napier's). This is a rubber stem four inches long, carrying a shallow rubber cup from two to three inches in diameter at its upper end. The lower end is supported by four pieces of rubber tubing, which are attached to a waist-band. The cervix rests in the cup and is directly supported, together with the vaginal vault. It is employed for second and third degree prolapse, when a ring pessary cannot be retained, and when operation is contra-indicated. The disadvantages of its use are that it has to be removed every night, frequently causes pain, and often fails to give support, especially when cystocele is pronounced. A modified type is that in which the ordinary watch-spring pessary is supported by a rubber-covered stem and coiled watch-spring. The purpose of this is to supply elastic pressure upwards and circumferentially.

Ball Pessary. This is a rubber ball with a tube attached, permitting it to be inflated after insertion. It is used when a ring pessary cannot be retained, when cup and stem pessaries are inefficient or cause pain, and when there is pronounced cystocele as well as prolapse. It has the advantage of exerting equal pressure in all directions upon the vaginal walls. It cannot be used, however, if the vaginal outlet is not sufficiently taut to keep it in place.

Pessary treatment is advised :

- (a) When operation is contra-indicated or refused.
- (b) In order to maintain in position a corrected retroversion immediately after confinement.
- (c) To determine whether or not correction of the retroversion relieves the patient's symptoms.

Contra-indications to the use of a pessary are :

- (a) Inability to retain it in position without undue tension, as when the vaginal entrance is relaxed.

- (b) Uncorrected retroversion of the uterus with prolapsed ovaries.
- (c) Pelvic inflammation.
- (d) Youth of the patient.

General Regime for Patients Wearing Pessaries. The patient should know the type and size of the pessary worn, so that it may be changed by any practitioner. There need be no interference with sexual life, except when pessaries with crossbars and diaphragms are worn. A cup and stem pessary is removed every night and reinserted before rising in the morning. Other types are changed every three months. A douche (lysol or dettol, 1 drachm to the quart, using 2 quarts at 112°–115° F.) is used daily. If there is no discharge this may be limited to twice weekly. Bleeding or increase of discharge should be reported immediately for investigation. A useful method for estimating the size of a ring pessary is to pass the finger so as to reach the posterior fornix, the distance from this point to the urethra being noted. The diameter of the ring should be about half an inch short of this measurement, so that its lower border may lie just above the meatus. After the ring is inserted, the comfort of the patient is a useful guide as to tension; she should be unaware of its presence.

Operative Treatment. Prolapse of any appreciable degree is preferably treated by operation, as pessary life is uncomfortable and troublesome at best. This applies particularly to young or middle-aged patients. When a pessary is inefficient or causes pain, where bladder symptoms are present, such as frequency of micturition and incontinence on straining, or where there is chronic cervicitis, operation is advisable.

EPITOME OF TREATMENT FOR CASES OF PROLAPSE

- (1) A slight degree of cystocele with thin perineal body and relaxed levatores ani muscles; for this, posterior colpo-perineorrhaphy should be performed.
- (2) Pronounced cystocele and retroverted but mobile uterus which can be manually restored to anteflexion; here anterior colporrhaphy, or preferably the Fothergill operation followed by colpo-perineorrhaphy, is the operation of choice.
- (3) (a) There is prolapse of the second and third degree.
 - (b) The cervix is chronically infected, lacerated, or enlarged.
 - (c) There is supra-vaginal elongation of the cervix.

Fothergill's operation is the most suitable for *all* these conditions (see page 2429).

(4) Where there is any degree of prolapse, and removal of the uterus is also indicated for either malignant or non-malignant condition of the body: here vaginal hysterectomy is advocated (see page 2425).

(5) Where there is fixed retroversion of the uterus, and where there is chronic salpingo-oöphoritis or a large fibroid; here also abdominal operation may be necessary.

CYSTS

Cysts of many varieties are found in the walls of the vagina. Some types are common, but the majority are very rare.

Cysts may occur

- (1) In the lower part of the Wolffian duct (Gartner's duct).
- (2) In the Wolffian tubules.
- (3) In Max Schuller's glands.
- (4) In Skene's tubules.
- (5) In aberrant mucous glands.
- (6) By implantation of epithelium.
- (7) By distension of lymphatic spaces.

Clinical Features. The commonest sites for cysts are low down in the vagina, either in the anterior wall as distended Schuller's glands, or in the posterior wall. Cysts of Wolffian remains are always outside the vagina, the wall of which moves freely over them. All other cysts are incorporated with the vaginal wall (fig. 1165).

Complications. Suppuration may take place in any of these cysts, particularly in those communicating with the floor of the urethra, and occasionally in those of Wolffian origin. The former may contain phosphatic calculi precipitated from the urine. Large cysts, if low down at the side of the vagina, may possibly obstruct labour.

Symptoms. These, if present, are usually mild. A cyst of the anterior wall may bulge through the vaginal entrance, simulating a cystocele, from which it is easily distinguished by passing a bladder sound. When a cyst is present, it intervenes between the finger and sound. On rare occasions there may even be dyspareunia.

Signs. A smooth rounded swelling beneath the mucosa, varying in size from a quarter of an inch to three inches in diameter, is seen and felt.

Treatment. Cysts in the anterior wall, either communicating with the urethra or protruding from the vaginal entrance, should be removed by dissection. When opening into the urethra, the communication should be carefully occluded. Other cysts, when small, require no treatment. When large, an attempt should be made to remove them by dissection, care being taken to avoid injury to the urethra, bladder,

rectum or ureters. When removal is impossible, the cyst should be opened up freely, converting its cavity into a part of the vaginal wall. The lining cells of the cyst undergo metaplasia into stratified epithelium. Large cysts of the Wolffian duct growing beside the uterus above the

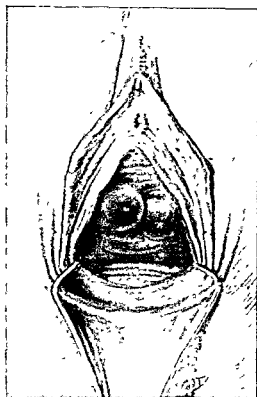


Fig. 1165.—VAGINAL CISTS. TWO SMALL CISTS ARE SEEN IN THE ANTERIOR VAGINAL WALL.

vaginal vault can be more advantageously removed by abdominal section, or be obliterated by means of sclerosing solutions (see page 2424). When suppuration has occurred, drainage is usually all that is necessary. The inflammatory process tends to destroy the lining epithelium, and thereby effect a cure.

NEW GROWTHS

- | | | |
|----------------|---------------------------------|--|
| (1) Innocent. | (a) Fibroma and fibromyoma. | |
| | (b) Adenomyoma or endometrioma. | |
| (2) Malignant. | (a) Primary. | (i) Carcinoma. (ii) Sarcoma. |
| | (b) Secondary. | (i) Carcinoma. (ii) Chorionic carcinoma. |

New growths of the vagina are very uncommon, with the exception of secondary invasion from carcinoma of the cervix.

Innocent New Growths. Fibroma and Fibromyoma. These are very rare and occur as small movable growths in the vaginal wall. They are formed of masses of fibrous tissue, sometimes with plain muscle intermixed. They seldom attain sufficient size to obstruct the vagina. Occasionally they become pedunculated, hanging outside the entrance, or they may ulcerate, giving rise to bleeding and discharge.

Symptoms. There are usually none, although dyspareunia and even obstruction of the urethra may occur. Discharge and bleeding will be present when there is ulceration, and here differentiation will have to be made from carcinoma of the vagina.

Treatment. The growth should be removed by enucleation.

Adenomyoma or Endometrioma. This is chiefly encountered in the posterior vaginal fornix and recto-vaginal septum. Histologically this growth is composed of gland tubules lined with cubical epithelium and surrounded by a cellular stroma, resembling endometrium. Fibrous tissue and smooth muscle are usually seen in association with the endometrial elements, and for this reason the term "adenomyoma" has been used. Although these growths are not regarded as malignant, they have no capsule and may invade the vaginal vault and recto-vaginal septum.

Signs and Symptoms. Pain is usually felt at the time of menstruation, when there may be bleeding from the growth as well as from the uterus. A firm nodular induration is felt in the posterior fornix and recto-vaginal septum.

Treatment. When there is pain or a definite and progressive increase in size, operation or radium treatment should be advised.

Malignant New Growths. Primary Carcinoma. This is exceedingly rare, is squamous-celled, and rapidly ulcerates. The urethra and rectum become involved at an early stage.

Signs and Symptoms. There is pain, irregular bleeding and foul discharge in the course of the disease. A hard irregular friable ulcer can be felt in the vaginal wall, and this must be differentiated from a fibroma undergoing necrosis. A section examined under the microscope will show the typical appearance of a squamous-celled carcinoma.

Treatment. If discovered at an early stage, the growth may be excised and the pelvic tissues subjected to deep X-ray therapy; radium treatment, however, is preferable in the majority of cases.

Primary Sarcoma. This is an extremely rare growth, arising in the paravaginal connective tissues and forming a hard, dark-coloured mass which bulges into the vagina. Growth is rapid, ulceration occurs early, and polypoidal outgrowths may develop. Histologically it may resemble any type of sarcoma.

Treatment. Excision is seldom possible, and radium or X-rays should be employed.

Secondary Malignant Growths. Carcinoma. This is much more common than the primary growth. The vaginal vault becomes invaded by direct extension from carcinoma of the cervix, or from the urethra or vulva. It has been thought that implantation into the vaginal wall may result from the escape of malignant cells from the cervix or body of the uterus. I have seen a case of carcinoma of the cervix in

which there were three nodules in a vertical line near the vaginal entrance posteriorly. A section from one of these nodules was identical in appearance with the growth in the cervix.

Symptoms are usually those of the primary growth.

Treatment. Radium or deep X-ray therapy is advised, as excision is usually out of the question in most cases of malignant growth of the vagina.

Chorionic Carcinoma. This is always secondary to a growth in the uterus, and is usually seen as single or multiple dark purple nodules, resembling small hæmatomata in the vaginal wall. If occurring after labour, abortion, or especially after vesicular mole, it is strong evidence that the malignant condition has developed in the uterus. These nodules should always be removed at once and examined microscopically.

Treatment. Total hysterectomy should be performed, the nodules excised, and the whole pelvis subjected to deep X-ray therapy. The Aschheim-Zondek, Friedman, or other pregnancy test should be made following treatment and at frequent intervals afterwards. When the test is positive it indicates the presence of actively-growing chorionic elements. Secondary growths when discovered in any part of the body should be treated by deep X-rays, as they yield readily to such treatment. Although chorionic carcinoma is an extremely malignant growth, secondaries often disappear spontaneously, a possible explanation of this being that the chorionic elements rapidly erode small blood-vessels, and the resulting hæmorrhage causes necrosis of the neoplasm.

CHAPTER V

CERVIX UTERI

AFFECTIONS of the cervix uteri may be classified as follows:

- (1) Maldevelopments.
- (2) Injuries.
- (3) Inflammations.
- (4) Cystic degenerations.
- (5) New growths: (a) innocent; (b) malignant.

MALDEVELOPMENTS

(a) *Conical cervix*. This is a smaller cervix than the normal, and its presence is an indication of under-development of the uterus—the small adult type (fig. 1166).

The “pin-hole” as said to occur in these cases is really a misnomer, for if the external os be wiped vigorously with a strip of gauze it will be seen that this opening is very little smaller than the normal.

(b) *Double cervix*. This condition is occasionally seen in connection with some form of double uterus, and may be associated with a vaginal septum.

(c) *Atresia of the cervix* is seldom seen except in cases where there is a double uterus and cervix, when one of the cervixes may be occluded, with a resulting accumulation of menstrual fluid.

Acquired atresia sometimes follows cauterisation of the cervical canal, the use of radium, and on rare occasions amputation of the cervix. It is seldom complete.

(d) *Congenital elongation* is a very rare condition in which the vaginal portion of the cervix is so greatly elongated that it may even

protrude from the vagina. It must be distinguished from prolapse of the uterus and vaginal vault, and from supra-vaginal elongation of the cervix. In the two latter conditions the vaginal vault descends and the fornices are below their normal level. When the vault is pushed up, the cervix still lies inside the vagina and cannot be elevated.

Treatment. The elongated portion should be amputated. (See page 2460.)

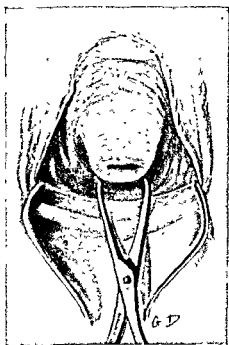


Fig. 1166.—CONICAL CERVIX.

(e) *Supra-vaginal elongation* is always acquired as the result of the downward dragging of a cystocele and, to a lesser degree, of a rectocele.

Occasionally the condition occurs in a pronounced form after ventro-fixation of the uterus when the vaginal prolapse is left untreated.

Treatment. (See page 2429.)

INJURIES

Injuries which almost invariably result from labour comprise either (a) lacerations, or (b) vesico-vaginal fistulae.

Lacerations, which may be of any depth, are exceedingly common, the most usual occurring laterally, affecting one or both sides of the cervix.

Cervical lacerations are usually due to rapid or even precipitate labour, or to the application of forceps before the cervix is fully dilated (fig. 1167).

Results. Ectropion, or exposure of the cervical mucous membrane, follows, and the everted lips become covered with columnar epithelium (fig. 1168).

Symptoms. Profuse discharge and backache are usually present and are characteristic features.

Treatment. (See page 2460.)

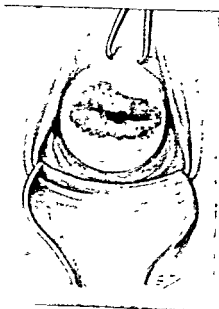


Fig. 1167.—BILATERAL LACERATIONS OF THE CERVIX, ASSOCIATED WITH EROSION.

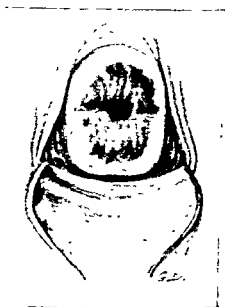


Fig. 1168.—BILATERAL LACERATION WITH ECTROPION. THE INNER ASPECTS OF THE EVERTED LIPS ARE COVERED WITH COLUMNAR EPITHELIUM.

Vesico-cervical fistulae are very rare. They are due as a rule to pressure of the foetal head against the pubic bones during labour, but sometimes to lacerations extending into the base of the bladder.

INFLAMMATIONS

Cervicitis (endocervicitis). Inflammations of the cervix, usually known as cervicitis or endocervicitis, are amongst the commonest of gynaecological affections. They are important because of their frequency, the discomfort they may produce, and the possibility of spread

of the infection to the endometrium, tubes and ovaries, and pelvic peritoneum.

Cervicitis may be acute or chronic.

Acute cervicitis may be gonorrhœal or septic.

Gonorrhœal cervitis is due to the gonococcus which attacks the mucous lining and glands of the cervix, burrowing through the epithelium and invading the sub-epithelial tissues. No breach of surface is necessary for its entrance. Almost invariably the infection is transmitted during sexual intercourse. Occasionally the cervix alone is affected, but more commonly there is a wider infection, including the urethra, occasionally the ducts of Bartholin's glands, and, on very rare occasions in adults, the lining of the vagina.

Symptoms and signs. There are few symptoms attributable to cervicitis *per se*, except discharge, which is at first mucous, later becoming muco-purulent. There may, however, be slight backache. Upon inspection the cervix is seen to be red and congested, and a bright red ring of mucosa, due to swelling, protrudes slightly from the external os. At this stage the gonococcus can frequently be seen on microscopical examination of the pus, and can often be grown on a suitable culture medium.

The infection in the cervix tends to lie dormant for a very long time, frequently for years if left untreated. The acute stage subsides, discharge diminishes, an erosion or mucous patch develops, and the condition becomes chronic.

Diagnosis. *Acute cervicitis*, arising apart from labour or abortion, especially if associated with vulvitis, urethritis or Bartholinitis, is presumably gonococcal in origin. The diagnosis is made absolute only when the gonococcus is seen on microscopical examination of the pus, or is cultivated from smears taken from the cervix.

Septic cervicitis is due to the infection of a laceration of the cervix during labour, and on rare occasions follows operation, such as trachelorrhaphy or amputation of the cervix. The infecting organisms are most commonly the streptococcus and staphylococcus.

Symptoms and signs. Purulent vaginal discharge is present, together with mild fever and lower abdominal and sacral pain. On inspection the laceration of the cervix may be seen covered with a greyish exudate and pus.

Frequently a septic laceration of the cervix is only part of a more extensive infection, such as septic endometritis, salpingitis, pelvic peritonitis, pelvic cellulitis, and possibly septicæmia. If the infection is limited to the cervix, the suppuration will usually subside in about a fortnight.

Treatment. This consists of rest in bed in a sitting position to promote drainage, together with antiseptic douches, such as potassium permanganate 1 in 2000, or zinc sulphate 1 drachm to the pint; 3 quarts are used at 115–118° F. twice daily. Three months after the infection has cleared up, the laceration should be repaired by the operation of trachelorrhaphy, or, if there is much hypertrophy of the cervix, by amputation. (See pages 2456 and 2460.)

Chronic cervicitis (chronic cervical catarrh). This is a chronic inflammation of the mucous membrane and glands of the cervical canal, together with involvement of the underlying muscle, tending to cause fibrosis and enlargement of the cervix.

Causes. These may be (a) gonococcal; or (b) pyogenic: (i) as a result of infection of a laceration due to labour or abortion; or (ii) arising obscurely in nulliparæ and virgins.

Early effects. There is leucocytic infiltration of the sub-epithelial cervical tissues. Around the external os fairly characteristic changes are seen. There is a shedding of the squamous cells and at the same time an overgrowth of the columnar epithelium which spreads out from the canal over the denuded area and may extend to a distance of $\frac{1}{2}$ inch from the os. This area covered by columnar epithelium is known as an erosion or catarrhal patch. The term "erosion" is not strictly correct, for there is no ulceration or loss of tissue. As a result of continued stimulation by the inflammatory process, the columnar epithelium rapidly proliferates, with the result that the erosion may assume one of two forms: (a) papillary erosion, in which there is a heaping up of fine fibrillary and cellular processes, forming papillary projections (fig. 1169); or (b) follicular erosion, in which crypts lined with columnar epithelium dip down into the fibro-muscular substance of the cervix—a new glandular formation (fig. 1170).

Later effects. The deep glands of the cervical canal tend to become blocked by swelling of the tissues, and retention cysts are formed. Those near the os approach the surface upon which they rupture, forming a deep crypt lined with columnar epithelium. Some of these

cysts remain under the surface of the erosion and are known as Naboth's follicles.

Remote effects. The inflammatory process continues, spreading deeply into the cervix, causing fibrosis, with the result that the cervix becomes enlarged and hardened, and, if there has been previous laceration, the lips of the cervix become everted, exposing the columnar epithelium of the canal—ectropion (see fig. 1168). Later, hypertrophy of the mucosa of the canal produces polypoid projections, which in time form stalked bodies—mucous polypi.

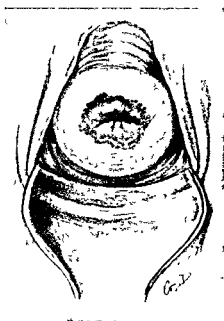


Fig. 1169.—CERVICAL EROSION, PAPILLARY TYPE.

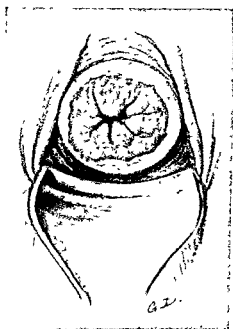


Fig. 1170.—FOLLICULAR EROSION.

Symptoms. There are two constant and fairly characteristic symptoms: (a) leucorrhœa, and (b) backache.

Leucorrhœa, muco-purulent in character and variable in amount, is a constant accompaniment of cervicitis.

Backache is a frequent complaint and may be due to the cervicitis alone. There is often present, also, a secondary chronic inflammation of the cellular tissues of the utero-sacral and the bases of the broad ligaments.

Secondary effects, such as pruritus and irritation of the vulva and excoriation of the peri-anal, peri-vulval and perineal skin, sometimes extending up to the groins and along the ischio-natal cleft, frequently occur as a result of the leucorrhœa.

During pregnancy the discharge is much more profuse owing to the

greater vascularity of the cervix. It appears that during the puerperium a chronic cervical infection only slightly increases the risk of uterine infection. A chronic gonococcal cervicitis is liable to cause a severe ophthalmia in the new-born.

Diagnosis. The condition must be distinguished from :

- (a) Carcinoma.
- (b) Tuberculosis.
- (c) Hard chancre.

Carcinoma. When carcinoma is present the cervix is hard and friable, granular in appearance if ulcerating, and papillary, ragged and irregular if fungating. The surface bleeds freely when rubbed with the finger, a fragment can be removed easily with a sharp curette, or a probe can be made to sink readily into its substance. When the cervix is grasped with a vulsellum, the instrument cuts through and fails to secure a firm hold on the friable tissues.

Tuberculous cervicitis is very rare. The proliferating type resembles an erosion, but is friable and bleeds readily.

Hard chancre, which is characterised by marked nodulation and redness of the surface, is rarely seen on the cervix.

In making a differential diagnosis between cervicitis and growth a small portion of the cervical tissues should be removed and examined microscopically.

Treatment.

- (a) Applications of antiseptics.
- (b) Ionization.
- (c) Operation : (i) removal of the gland-bearing portion of the cervix with the diathermy loop (see page 2463) ; (ii) amputation of the cervix (see page 2460) ; (iii) trachelorrhaphy (see page 2456) ; or (iv) total hysterectomy (see page 2481).

Antiseptic applications should be given a trial. If profuse discharge continues after treatment by this means, the gland-bearing portion of the cervix should be removed with the diathermy loop, or by amputation. In all cases in which the cervix is deeply lacerated or enlarged and fibrous, amputation is indicated.

Cases of recent cervical laceration, with profuse discharge but without induration or hypertrophy, can often be satisfactorily treated by trachelorrhaphy. Profuse discharge is frequently due to dilatation of the cervical canal, a condition which can sometimes be cured by operation for reduction of the canal (see page 2458).

CYSTIC DEGENERATION

Cystic degeneration of the cervical glands is a rare condition in which the crypts are distended, frequently to a considerable size, and the whole cervix may be extensively involved.

Treatment. Where distension is slight, high amputation of this distended portion should be attempted, but in the presence of extensive involvement and enlargement total abdominal hysterectomy is indicated.

NEW GROWTHS

These may be considered under the following groups: (a) *Innocent*: (i) mucous polypus; (ii) fibromyoma. (b) *Malignant*: (i) carcinoma, endocervical or arising in the portio vaginalis; (ii) sarcoma.

Innocent New Growths

Mucous Polypus. This is the commonest new growth of the cervix. It is benign and due to hypertrophy of the cervical mucosa as the

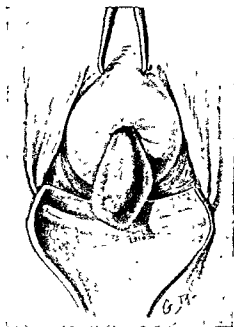


Fig. 1171.—MUCOUS POLYPUS OF THE CERVIX.

result of inflammation. It usually occurs as a small stalked body, varying in size from a pin's head to a walnut, attached inside the cervix or at the external os (fig. 1171). The stalk may be so long that the polypus appears outside the vulva.

Microscopically it is seen to consist of a stroma of connective tissue together with blood-vessels and gland crypts lined with columnar epithelium identical with that lining the cervix. The surface is covered with stratified epithelium. The crypts frequently become cystic from blocking of their orifices. There is no evidence that mucous polypi ever become malignant.

Symptoms. Discharge and irregularly recurring slight hæmorrhages, often as little as a few drops, are characteristic symptoms.

Treatment. (See page 2464.)

Fibromyoma. Five per cent of all fibroids occur in the cervix. They are always single, and may attain to a large size. Pathologically they are identical with those occurring in the body of the uterus, and are subject to the same degenerations and changes.

They may be submucosal or interstitial.

Submucous Cervical Fibroids are usually small and tend to become extruded, forming hard polypi and giving rise to irregular bleeding and discharge.

Interstitial Cervical Fibroids expand and elongate the cervical canal according to the size of the tumour. The vaginal vault is pulled upwards and the portio vaginalis is obliterated. The bladder is often elevated, the ureter is displaced upwards and outwards, and the uterine artery is elevated above the tumour. The uterine body is lifted up, being perched on top of the growth.

Menorrhagia is seldom caused by cervical fibroids, but there may be pelvic pain, difficulty in micturition, or even complete retention of urine. On rare occasions hydronephrosis may be caused by compression or kinking of the ureters, and there may be partial obstruction of the rectum.

As these tumours obstruct labour Cæsarean section will be necessary if the patient becomes pregnant.

A firm rounded tumour of the consistency of a fibroid is felt in the pelvis, incorporated with the cervix which is frequently drawn high up. The uterine body can occasionally be palpated resting on the top of, and attached to, the expanded cervix. The passing of a sound will show that the canal is elongated and describes a circuitous route around the tumour.

Treatment. (See page 2495.)

Malignant New Growths

Carcinoma. The cervix is the commonest site of cancer in women. It is thirty times as common as carcinoma of the body of the uterus. At present in England and Wales the deaths annually from cancer of the uterus are about 4300—about 7 per cent of all deaths from cancer.

Etiological Factors. Age is important. Ninety-three per cent of cases occur between the ages of 40 and 55. Between 25 and 35 the disease is rare. After 55 the frequency index rapidly declines.

Childbearing is undoubtedly the greatest predisposing factor. At least 97 per cent of cases are in women who have had children. There seems to be some relationship between great fertility and incidence of cancer.

Lacerations and Cervicitis. The fact that cervicitis and lacerations occur chiefly in parous women accounts for the greater frequency with which carcinoma of the cervix occurs in such patients.

"*Erosion*" being due to chronic inflammation, cancer is more likely to develop where this is present, but does not arise from the columnar epithelium which always covers the so-called erosion.

The disease is more frequently seen in patients of the poorer classes.

Pathology. The two sites in which the growth develops are the portio vaginalis and the cervical canal.

Carcinoma of the Portio Vaginalis is the commoner form. It begins near the external os as a deep red indurated patch or as a firm nodule, but is seldom seen at this stage. The growth may remain on one side of the cervix, but usually the whole cervix becomes infiltrated (fig. 1172).

Growth and necrosis proceed together, and the normal tissues are replaced by carcinoma cells which break down, forming an increasingly wide and deep ulcer. In this way the tissues of the cervix, later of the vaginal vault, and finally of the base of the bladder, are invaded and destroyed.

When the growth is of the hypertrophic type, necrosis proceeds more slowly, and large papillomatous-looking masses bulge into the vagina.

Histological appearance. The tumour is a squamous-celled carcinoma, resembling similar growths in other parts of the body (fig. 1173). The main portion is composed of solid masses of squamous epithelial cells, but cell-nests with keratinoid change in the centre are not a marked feature. At the margin of the growth solid branching processes can be seen growing downwards into the corium and underlying fibro-

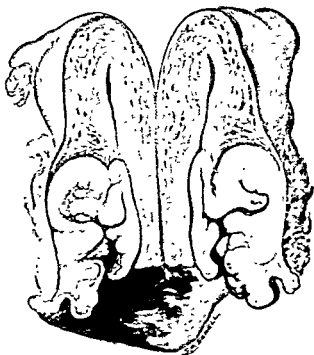


Fig. 1172.—CARCINOMA GROWING IN THE ANTERIOR LIP OF THE CERVIX WHICH HAS BEEN ALMOST COMPLETELY REPLACED BY THE NEOPLASM. (M^{rs}, R.C.S.)

muscular tissue. A round-celled infiltration is always present in the surrounding tissues and, in the early stages, in the epithelial columns. Processes of carcinomatous cells appear among the muscle bundles and in the lymphatic vessels.

Carcinoma of the Cervical Canal. This type is much less common than that previously described. The growth springs from the columnar epithelium lining the cervix and cervical glands. Infiltration is a pronounced characteristic, and the whole cervix becomes invaded (fig. 1174). Ulceration occurs later than in the squamous-celled type and tends to produce one of two conditions: either a complete hollowing-out of the cervix, which is left as an indurated shell; or complete destruction of the cervix, which is replaced by a deep ulcer surrounded by an indurated zone.



Fig. 1173.—SQUAMOUS CELLED CARCINOMA OF THE VAGINAL PORTION OF THE CERVIX. ON THE LEFT, IRREGULAR MASSES OF EPITHELIAL CELLS ARE INVADING THE FIBRO-MUSCULAR STROMA OF THE CERVIX. ON THE RIGHT IS THE NORMAL STRATIFIED EPITHELIUM.

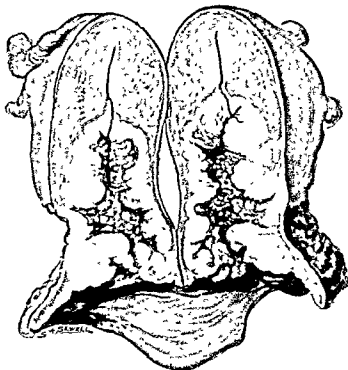


Fig. 1174.—ENDOCEVICAL CARCINOMA OF THE CERVIX. THE CARCINOMATOUS GROWTH EXTENDS UPWARDS TO THE INTERNAL OS AND DOWNWARDS SO AS TO REPLACE ALMOST COMPLETELY THE VAGINAL PORTION OF THE CERVIX. (*Mun., R.C.S.*)

Histological appearance. This growth is a columnar-celled carcinoma composed of ingrowing hollow tubules resembling the columnar-celled carcinoma which occurs in the bowel. The tubules are lined with heaped-up, irregularly proliferating, large, epithelial cells, and are occasionally completely filled with masses of these cells. There is always a round-celled infiltration accompanying the growth.

Modes of Extension. The growth may spread by :

- (i) Infiltration.
- (ii) Lymphatic permeation.
- (iii) Dissemination by the blood stream.
- (iv) Implantation.

Infiltration. Processes composed of malignant cells penetrate into and destroy the surrounding tissues. In this way the vaginal portion of the cervix, the vaginal wall, the base of the bladder in front, the pouch of Douglas behind, and the broad ligaments laterally are invaded. Infiltration of the uterine wall above the level of the internal os does not occur until the disease is well advanced. It is more rapid and extensive in the columnar- than in the squamous-celled type.

Lymphatic permeation. Even when the growth is advanced, lymphatic glandular deposits are much less frequent than they are when carcinoma occurs in other parts of the body. In both squamous- and columnar-celled types secondaries usually occur late, and may even be absent in patients dying from the disease. Chains of carcinomatous cells fill the lymphatics of the cervix and may proceed via the lymphatics of the broad ligament to a small gland near the uterine artery in the base of the broad ligament, to glands along the external and internal iliac vessels and in the obturator fossa, along the common iliac vessels, and finally to glands of the pre-aortic group ; and/or via the lymphatics of the utero-sacral ligaments to the lateral sacral, and thence to glands in the region of the pelvic mesocolon.

Dissemination by the blood stream. Small groups of cells may break loose and be carried by the blood stream to distant organs and structures, such as the lungs, liver and peritoneum, but spread in this way is rare, occurring late in the disease and affecting probably less than 10 per cent of cases.

Implantation. Isolated growths are occasionally seen in the vagina. These are thought to be implants. I have seen a case in which three nodules, in line from above downwards, grew in the lowest part of the vagina near the entrance and were completely isolated from the excavating growth in the cervix. Microscopically they were seen to be nests of squamous epithelioma.

Symptoms. These are considered in the order in which they usually appear.

(i) Thin serous or watery discharge.

(ii) Bleeding on coitus, occasionally noticed first by the husband. This is a symptom which calls for immediate investigation.

(iii) Irregular bleeding, at first slight and occasional, later increasing until more or less continuous and free.

(iv) Discharge, blood-stained, and later foul-smelling as a result of infection following ulceration of the growth.

(v) Cachexia; the patient has a sallow, ashen-grey appearance, and shows signs of wasting and anæmia.

(vi) Pain. This is always a late symptom, due to invasion of the cellular tissues of the pelvis by growth and inflammatory exudate. It is usually felt in the sacral region, vagina, and down the thighs.

(vii) Frequency of micturition, pain on passing urine, and hæmaturia indicate that the trigone of the bladder is invaded by growth and inflammatory exudate. Constant dribbling of urine occurs when the ulcerative process has led to the formation of a fistula.

* Carcinoma of the cervix never causes menorrhagia.

Signs. These will vary with the type and stage of the growth.

Signs of Carcinoma of the Portio Vaginalis:

(i) *Indurated Nodule or Patch.* The disease very seldom comes under investigation at this early stage. I have seen one case with a deep red area with a firm sub-structure about the size of a threepenny piece. It did not bleed on rubbing with the finger or gauze, and was not friable when the sharp curette was applied. A wedge examined microscopically had the appearance of typical squamous-celled carcinoma.

Schiller's Test is especially applicable to early cases of carcinoma of the portio vaginalis but not to endocervical growths.

SCHILLER'S TEST

According to Schiller, normal epithelium of the cervix contains glycogen in its superficial layers. When the normal cervix is painted with Lugol's solution (iodine 1 part; potass. iod. 2 parts; water 300 parts) the epithelium takes on a mahogany brown colour in about one minute's time. This is due to the fact that the glycogen in the superficial cells is stained by the iodine.

There are three conditions which prevent the surface of the cervix from staining in this way :

- (1) The presence of an early *carcinomatous layer* ;
- (2) *Hyperkeratosis* due to the trauma of prolapse or consequent upon syphilitic infection ; and
- (3) *Desquamation* of the superficial layers of the glycogenic epithelium as the result of scraping with sharp instruments.

While the growth is as yet a *carcinomatous layer*, the test is of great clinical value. The *carcinomatous* cells show up as a white area surrounded by the brown-stained normal epithelium. Later, when ulceration occurs, the *carcinomatous* cells become necrotic and stained brown with iodine, and the method is not then so helpful. By this time, however, the growth is of such appearance and character as to be recognisable with the naked eye, or to be such as to arouse suspicion and lead to removal of a section for investigation. There may, however, be a white area surrounding the malignant ulcer when the growth is still in the early stages of a *carcinomatous layer* of cells on the surface, as previously stated.

This iodine test of Schiller affords an important and readily applicable means of investigating the cervixes of all patients presenting themselves for gynaecological examination. The margin of error according to Schiller is probably not more than 1.5 per cent.

(ii) *Proliferating or Fungating Growth* which bulges into the vault of the vagina. This bleeds freely when rubbed, and can be broken up with the finger or cut with a sharp curette (fig. 1175).

(iii) *Excavating Ulcer* which presents a ragged indurated funnel-shaped hollow in the region of the vaginal part of the cervix (fig. 1176). The base of this ulcer is exceedingly friable, crumbling under the finger, probe or sharp curette. Induration of variable extent surrounds the ulcer.

Signs of Endocervical Carcinoma :

In the *early stages* the vaginal portion of the cervix may be normal in consistency. The supra-vaginal portion, however, is barrel-shaped, a very characteristic sign which is noted chiefly on rectal examination. Induration is pronounced, and the consistency of the

cervix bears strong contrast to the softer uterine body above. The lining of the cervix, however, is *friable*, the passage of a probe will cause bleeding, and a sharp curette inserted into the canal can be made to cut into and remove a fragment from its wall.

In the *later stages* the cervix becomes hard and is usually replaced by a deep ulcer extending the whole length of the cervix, with hard friable walls which bleed readily on rubbing with the finger and can be cut easily with a curette. Induration around the cervix is usually pronounced.

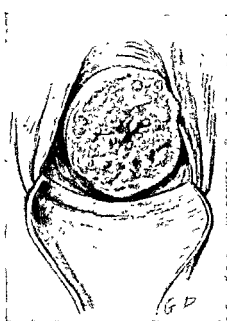


Fig. 1175.—CARCINOMA OF THE CERVIX, FUNGATING TYPE. THE CERVIX IS ENLARGED, VERY IRREGULAR IN OUTLINE, WITH A HEAPED-UP GROWTH, THE SURFACE OF WHICH IS NODULAR IN APPEARANCE.

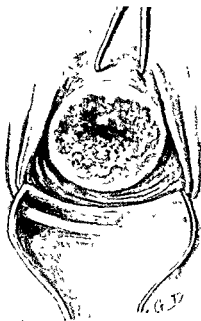


Fig. 1176.—EXCAVATING MALIGNANT ULCER OF THE CERVIX.

Signs of Extension of Carcinomatous Growths. Examination may be digital or instrumental, preferably under anaesthesia, and always with antiseptic precautions. It should be carried out by the following routes:

Per vaginam. The vaginal vault may be indurated and the vaginal portion of the cervix partially destroyed. The induration can be felt laterally, extending along the bases of the broad ligaments, and in advanced cases may reach the pelvic wall on one or both sides. Induration can also be felt posteriorly and anteriorly. Fixity of the cervix can be demonstrated by digital manipulation and by an attempt to pull it downwards with a vulsellum. Limitation of

movement is often an earlier sign than palpable extension of growth outside the cervix. On the other hand, there may be considerable downward movement, even though the bladder is involved.

Per rectum. Rectal examination may be digital and proctoscopic.

Digital investigation per rectum can be carried higher and wider than per vaginam. The utero-sacral ligaments can be felt as nodular firm ridges, passing backwards and upwards from the cervix. The extent of induration laterally in the broad ligaments can be palpated easily. Occasionally, enlarged and hardened lymphatic glands may be felt high up on the postero-lateral wall of the pelvis. If the rectum is invaded by the growth, a hard nodular zone can be felt in its anterior wall continuous with the indurated region in the cervix.

Proctoscopic examination will, in the earlier stages, show puckering of this indurated area; later, nodular masses and ulcers with bleeding granular bases may be seen.

Any sign of rectal invasion is evidence of an advanced stage of the growth.

Cystoscopic examination. This is important and should form part of any complete examination where there is evidence of growth. Before the trigone is actually invaded, congestion is first noticed, and later œdema. At this stage the bladder can easily be separated from the cervix at operation. Later, when the bladder is involved, there is puckering, irregular nodulation, and eventually fistula formation.

Diagnosis. Early diagnosis is of paramount importance. The following symptoms call for careful investigation: Irregular hæmorrhage between the periods, particularly in patients over the age of 40; post-menopausal bleeding; discharge which is watery, later becoming blood-stained or brownish; bleeding after coitus or douching.

The diagnosis is finally confirmed by microscopical examination of a fragment removed from the edge of the suspected area.

The following conditions may simulate carcinoma of the cervix at various stages: Erosion, laceration with cervicitis, chronic cervicitis, small cervical fibroid, sloughing fibroid polypus, and, rarely, ulceration of the cervix due to tuberculosis or syphilis.

Erosion. The eroded portion of the cervix is superficially soft with a firm substratum, smooth, not friable, and has no palpable edge. In colour it is uniformly bright red. The condition must be differentiated

from a very early nodule or indurated patch, which is firmer in consistency, can sometimes be penetrated with a sound, is dark red in colour, may possibly bleed when rubbed, and will give a positive Schiller test.

Laceration with Cervicitis. This condition is usually confined to one or both sides of the cervix, which is firm in consistency, tough when grasped with the vulsellum, and is not friable to the curette or sound.

Carcinoma, on the other hand, usually involves the whole cervix around the os, and produces an ulcer with rough, hard, friable walls.

Chronic Cervicitis of some standing causes uniform enlargement and firmness of the vaginal portion of the cervix, which is tough and is not friable to the sharp curette or probe. Chronic cervicitis must be distinguished from endocervical carcinoma, in which the cervix is characteristically barrel-shaped, the supra-vaginal portion in particular being enlarged. The lips of the cervix may not be hard, but the passage of a sound will cause bleeding. A portion of the growth can be readily removed by passing a sharp curette into the canal. The uterine body feels soft and small compared with the enlarged hard cervix.

A small Cervical Fibroid causes uniform enlargement of the cervix, with elongation of the canal. Dilatation does not cause bleeding, and the wall of the canal is tough and cannot be cut with a sharp curette.

Sloughing Fibroid Polypus. The cervix may present a ragged necrotic bleeding mass with offensive discharge. Some portion of the polypus will feel tough when held with the vulsellum. When the polypus is removed, a definite stalk will be found and the dilated cervical canal will be smooth and not friable. Differentiation must be made from a fungating endocervical carcinoma, in which soft, bleeding, friable masses appear at the external os. No stalk will be found, but as the growth is removed further masses will appear.

Ulceration due to Tuberculosis or Syphilis. Ulceration from either of these conditions is very rare. A tuberculous ulcer frequently cannot be differentiated from carcinoma of the portio vaginalis, as the cervix is hypertrophied and very friable. Microscopical examination of a fragment of the cervix in a case of tuberculous ulcer will reveal inflammatory reaction, such as round-celled infiltration, together with giant-cell systems. A syphilitic chancre will be tough and not friable. Histological investigation will reveal a round-celled infiltration and overgrowth of fibrous tissue.

Associated conditions such as pyometra, pyosalpinx, hydronephrosis and pyelonephritis are frequently present and may be terminal factors.

Pyometra. Sooner or later the growth in the cervix becomes invaded by septic organisms and the infection may spread to the endometrium with resulting suppuration. Pus is liable to be retained, because the cervix is partly obliterated by the growth and contractility of the uterus is poor. The passage of a sound or dilator through the cervix will allow thick and extremely offensive pus to escape.

Constitutional symptoms, due to septic absorption, are uncommon, but occasionally there are rigors and high fever, together with rapid wasting, exhaustion, and eventually death. There may be rupture of the distended uterus, causing fatal peritonitis.

Pyosalpinx. This is often secondary to infection of the uterus, usually occurs late in the disease, and may also produce peritonitis with a fatal issue.

Hydronephrosis and Pyelonephritis. The ureters are not invaded in the early stages of the growth, which frequently spreads around them, leaving them lying in a tunnel in the invaded broad ligament. Later, however, compression or kinking may occur with consequent hydronephrosis. Infection of the kidney is liable to follow with fatal pyelonephritis.

Prognosis. It is difficult to estimate the possible duration of life, as terminal complications may arise at any time. The average duration is said to be about 18 months from the date of the first symptom, but it may vary from 6 months to as much as 5 years. The progress of the disease is much more rapid in women below the age of 40, whilst complications, such as sepsis and hæmorrhage, are more liable to occur in patients over 65.

Causes of Death :

- (1) Exhaustion from pain and septic absorption.
- (2) Bleeding, either as a slow continuous loss or as a sudden severe hæmorrhage such as may result from erosion of a large branch of the uterine artery.
- (3) Uræmia from ureteric obstruction.
- (4) Pyelonephritis.

- (5) Peritonitis following pyometra and pyosalpinx.
- (6) Embolism, intestinal obstruction, or secondary growths. These, however, are rare causes of death.

Treatment. This may be operative (see page 2523) or radiological, by means of radium or deep X-ray therapy (see page 1643).

Palliative Treatment. Cases which cannot be treated by any of the foregoing methods should be dealt with on the following lines :

Hæmorrhage is treated by packing the vagina with bismuth gauze after touching the surface with pure silver nitrate. Foul discharge is deodorised to some extent by irrigating the vagina with hydrogen peroxide (10 vol.).

Pain is inevitable, and anodynes should not be withheld. Aspirin 10 grs. t.d.s. should first be tried, but, as the pain increases, phenacetin, 5 grs., should be added, and later codeine $\frac{1}{4}$ – $\frac{1}{2}$ gr. In the advanced stages of the disease increasing doses of opium or its alkaloids will usually be necessary.

Cancer of the Cervix in Pregnancy. Cancer will, to some extent, prevent pregnancy as the discharges tend to kill the spermatozoa. A patient already pregnant may develop the growth, or pregnancy may occur while cancer is in the early stages. During pregnancy the growth will develop much more rapidly owing to increased vascularity of the cervix and possibly to hormonal stimulation.

Two probable associated dangers are :

- (1) Obstructed labour on account of poor dilatation of the cervix, which is invaded by the growth.
- (2) Infection of the uterus and septicæmia.

Treatment.

- (1) Operation.
- (2) Radio-therapy.

Operation is indicated :

(a) In early pregnancy with early carcinoma of the cervix. Here radical hysterocolpectomy should be advised (see page 2523).

(b) Where an early carcinoma is discovered complicating late pregnancy. Here Cæsarean section is performed, followed by radical hysterocolpectomy.

(c) Where there is a late pregnancy associated with an advanced carcinoma. Here there is a choice of treatment between operation and radium. Operative treatment consists of Cæsarean section, at or near term, together with sub-total hysterectomy to prevent the almost certain occurrence of sepsis of the uterus. Later, the growth may be treated by radium or deep X-ray therapy.

Radium Treatment. Radium treatment may be administered without interrupting the pregnancy. After radium treatment, the cervix is liable to become dense and fibrous, with the result that either dilatation is impossible or wide extensive lacerations of the cervix will occur on delivery. Thus, Cæsarean section will almost certainly be necessary in the majority of such cases. This operation, moreover, has two advantages: (i) It admits of exploration of the uterus in the neighbourhood of the internal os to determine whether or not any growth is still active in this situation; (ii) the glandular region can be examined and, if any secondary growths are in evidence, the glands can be removed at once or treated with deep X-rays at a later date.

Sarcoma of the Cervix. This is a rare condition, occurring in young girls and even in infants under one year of age. Growth is very rapid, and the tumour usually assumes a grape-like form (sarcoma botryoides), numerous polypoid branching masses growing down into the vagina, accompanied by extensive infiltration of the cervical and adjacent tissues.

Histologically the growth may consist of spindle cells arranged in bundles, or of a mixed growth containing striated muscle cells—rhabdo-myo-sarcoma. Other types, such as round-celled, spindle-celled, or mixed-celled, may also be encountered in the same tumour.

Symptoms. Bleeding, often free, and discharge are early symptoms. Uterine hæmorrhage occurring before puberty calls for vaginal examination, except in the new-born. Usually the growth is well advanced before it is discovered.

Treatment with radium per vaginam, combined with deep X-rays to the tissues of the pelvis, is the method of choice. When radium is not available, the uterus, tubes and ovaries should be completely removed, followed by the application of deep X-rays.

CHAPTER VI

UTERUS

THE following conditions will be described :

- (1) Maldevelopments: (a) under-developments;
(b) malformations.
- (2) Anomalies of function: (a) of menstruation;
(b) of pregnancy.
- (3) Displacements.
- (4) Inflammations.
- (5) Abnormal enlargements.
- (6) New growths: (a) innocent; (b) malignant.

MALDEVELOPMENTS

(a) *Under-developments* result from arrest of growth at any stage. There are three recognised types of under-developed uterus: (i) rudimentary; (ii) infantile; (iii) small adult (pubescent).

Rudimentary uterus is frequently associated with under-development of all the genital organs, and may accompany dwarfism, pituitary infantilism, cretinism or mongolism. This type of uterus consists of a small mass of fibrous and muscular tissue, usually without a cavity. Although the tubes and ovaries are as a rule normally developed, they also may be rudimentary, and the vagina may be partly or wholly absent.

Primary amenorrhœa and sterility are usual, although secondary sexual characteristics are in most cases well developed.

Infantile uterus results from arrest of growth at the stage which normally obtains before puberty. The whole uterus and cervix are less than 2 inches long, the cervix comprising two-thirds of the total length. The vagina, ovaries and tubes may be normal.

The *small adult type of uterus* is one that has failed to reach full development; the relative proportions of the cervix and the body of the uterus are normal, the former being conical, and the latter small, globular and often acutely anteflexed or retroflexed—cochleate (fig. 1177).

Clinical Features.

A *rudimentary or infantile uterus* is associated with complete and permanent amenorrhœa and sterility.

With the *small adult type of uterus* menstruation is late in onset, scanty in amount, and associated with long spells of amenorrhœa.

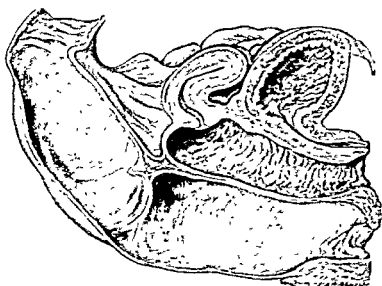


Fig. 1177.—COCHLEATE UTERUS. (Mun., E.C.S.)

Severe spasmodic dysmenorrhœa is very common, and although sterility is usual, it is not invariable. Should such patients become pregnant, repeated abortions are liable to occur. Pregnancies, however short, are a great stimulus to development, and a full-term pregnancy almost invariably follows several miscarriages. It is important to remember that some degree of pelvic contraction is often associated with this type of uterus.

Causes are not very clear, but it is probable that there is failure of the anterior pituitary to produce gonadotropic hormones which stimulate maturation of the Graafian follicles. The developing follicle in its turn produces œstrin, which has a marked stimulating effect, both on the uterine musculature and on the endometrium.

Treatment. In all types an attempt should be made to bring the uterus up to full development by injections of œstrin, 100,000 to 1,000,000 international units weekly. This in the light of Kaufmann's work (*Proc. Roy. Soc. Med.*, p. 849, Feb. 13, 1934) would seem to be comparatively easy in the small adult uterus, and to be a possibility in the infantile and even in the rudimentary types. To be effectual the dosage of œstrin must be large.

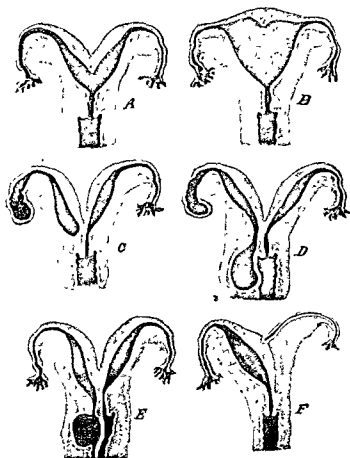


Fig. 1178a.

A=UTERUS BICORNIS UNICOLLIS.

B=UTERUS SUBSEPTUS.

C=UTERUS BICORNIS, ONE HORN OF WHICH DOES NOT COMMUNICATE WITH THE CERVIX. MENSTRUAL FLUID HAS ACCUMULATED, RESULTING IN A HÆMATOMETRA AND HÆMATOSALPINX ON THIS SIDE.

D=UTERUS BICORNIS BICOLLIS WITH DOUBLE VAGINA, ONE HALF OF WHICH IS CLOSED AT THE LOWER END. MENSTRUAL FLUID HAS ACCUMULATED, RESULTING IN HÆMATOCOLPOS, HÆMATOMETRA AND HÆMATOSALPINX.

E=UTERUS BICORNIS BICOLLIS WITH DOUBLE VAGINA, ONE HALF OF WHICH IS ATTENUATED AT THE LOWER END. MENSTRUAL FLUID HAS DISTENDED THE VAGINA ON THE AFFECTED SIDE ONLY.

F=UTERUS UNICORNIS WITH RUDDIMENTARY AND UNDER DEVELOPED HORN ON ONE SIDE WHICH IS OCCLUDED AT ITS UTERINE END; THE TUBE ATTACHED TO THE RUDDIMENTARY HORN IS WELL DEVELOPED.

(b) *Malformations.* Malformations of the uterus are due to faulty fusion of the posterior ends of the Müllerian ducts where they ordinarily meet and unite to form the uterus. Degrees of separation are recognised, varying from two completely separated small uteri to the remnant of a septum partially encroaching on the uterine cavity.

The following forms are found :

(i) *Uterus didelphys.* Here the uterus, cervix and vagina are double, only the two halves of the vagina being in co-aptation (fig. 1178B. I).

(ii) *Uterus bicornis bicollis.* The two horns are fused in the region of the cervices, which have each a separate opening. The vagina is septate (fig. 1178A. D and E).

(iii) *Uterus bicornis unicollis.* Fusion of the two horns has advanced to a further stage, there being only one cervix and two separate bodies (fig. 1178A. A).

(iv) *Uterus unicornis.* In this type one Müllerian duct is fully developed, producing a uterus with a Fallopian tube, cervix and vagina. The other Müllerian duct is present in very rudimentary form, frequently without a lumen or failing to communicate with the cavity of the developed horn ; the Fallopian tube on this side is often rudimentary (fig. 1178A. F).

(v) *Uterus subseptus.* The septum divides only the upper part of the uterine cavity (fig. 1178A. B).

(vi) *Uterus septus.* In this type a septum divides the uterine cavity, the cervix, and the vagina (fig. 1178B. H).

Clinical features. In all these malformations the vagina, cervix and uterus may function normally. Conception may take place in one or both halves of a double uterus, or in one or both horns of a bicornuate uterus. Labour may be normal and the malformation may never be suspected.

Three *dangers* may attend these malformations : (i) obstruction of labour ; (ii) stenosis of one half of the uterus ; (iii) pregnancy in a rudimentary horn.

Obstruction of labour. One horn of a double uterus may on rare occasions become impacted in the pelvis below the foetal head.

Stenosis of one horn may result in hæmatometra and hæmato-salpinx from retention of menses when development is sufficient for

menstruation to take place. On account of menstruation occurring from the developed horn the condition is not likely to be suspected until an abdominal swelling arising from one side of the pelvis calls

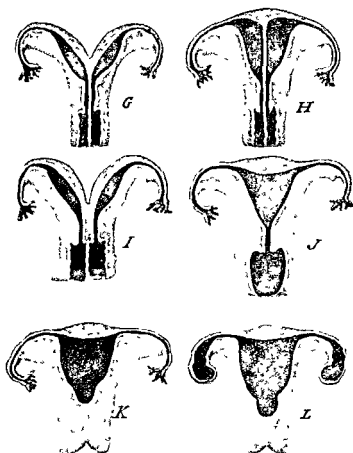


Fig. 1178B.

G=UTERUS BICORNIS BICOLLIS.

H=UTERUS SEPTUS: THE VAGINA IS ALSO SEPTATE.

I=UTERUS DIDELPHYS.

J=ATRESIA OF THE LOWER END OF THE VAGINA, THE UPPER PORTION OF WHICH IS DISTENDED WITH MENSTRUAL FLUID—HEMATOCOLPOS.

K=NON-CANALISATION OF THE VAGINA. THE UTERUS IS DISTENDED WITH MENSTRUAL FLUID—HEMATOMETRA.

L=ABSENCE OF VAGINA. THE UTERUS AND TUBES DISTENDED WITH MENSTRUAL FLUID—HEMATOMETRA AND HEMATOSALPINX.

for investigation. The presence of a double cervix should suggest this possibility. When there is a septate vagina, blood can be seen escaping from one side only.

Treatment. The affected half of the uterus should be removed by abdominal operation.

Pregnancy in a rudimentary horn can take place even when there is no communication between this and the normally developed half

of the uterus. Should this cornu be capable of growing to accommodate the pregnancy, full term may be reached, but this is most unusual. Rupture is likely to result, presenting all the signs and symptoms of tubal pregnancy and requiring the same operative treatment.

ANOMALIES OF FUNCTION

Anomalies of Menstruation :

- (1) Amenorrhœa.
- (2) Irregular menstruation.
 - (a) Epimenorrhœa.
 - (b) Hypomenorrhœa.
 - (c) Oligomenorrhœa.
- (3) Menorrhagia.
- (4) Dysmenorrhœa.
- (5) Intermenstrual pain.

Metrorrhagia and metrostaxis will also be briefly discussed in this chapter.

Before describing anomalies of menstruation, normal menstruation and the menopause will be briefly considered.

Menstruation is the periodic discharge of blood, mucus and endometrial shreds from the lining of the uterus. The periods usually recur every four weeks. The cycle may be reduced to 25 days, but is seldom longer than 30 days. The average duration of the flow is from 4-5 days; a period exceeding 6 days is probably due to some pathological lesion. The total average loss is about four ounces.

The menstrual fluid at the beginning of the onset consists chiefly of mucus from the endometrial and cervical glands, and later of blood and mucus to which is added shreds of endometrium composed of stroma and glands, showing the changes typical of the hypertrophy of the secretory or pre-menstrual phase. Bleeding is only truly menstrual when these fragments are present. The fluid is rich in calcium, contains no fibrin ferment, and normally does not coagulate. The passage of clots is abnormal, indicating excessive loss.

Constitutional symptoms. Pain of variable intensity attends the period in 75 per cent of women, and in 3 per cent is very severe,

requiring treatment. Malaise, lassitude and headache are very common. In association with the severe types of pain, indigestion and occasionally vomiting may be experienced. In a small percentage of cases irritability, mental depression and hysteria arise at this time.

The menstrual cycle is divided into three phases: (i) follicular; (ii) lutein; (iii) menstrual.

The follicular or proliferative phase. For 14 days the endometrial stroma and gland cells proliferate, resulting in thickening of the endometrium. At this time the ovarian follicle is ripening and elaborating œstrin in increasing amounts, but no progesterin is secreted. At the end of this phase the follicle ruptures and the ripe ovum is discharged.

The lutein or secretory phase lasts about 10 days. The endometrium continues to hypertrophy, the glands become enlarged, elongated and tortuous, and the lumina are filled with secretion. These changes are especially marked in the middle layer of the mucosa, giving this part a spongy appearance. The swollen gland cells contain a large amount of glycogen, the nuclei are pale and situated near the cell bases, while the superficial stroma cells enlarge, resembling decidual cells, and form a compact layer.

The menstrual phase. Blood is extravasated into the substance of the endometrium from rupture of the capillaries, and is discharged into the cavity of the uterus together with shreds of the mucosa and the contents of the uterine glands.

Causes of menstruation. The presence of the ovaries or part of an ovary is essential for menstruation. The ripening Graafian follicle produces a hormone (œstrin) which is responsible for the thickening in the endometrium in the first or follicular phase. When the follicle ruptures, the corpus luteum is formed, probably within a few hours, and elaborates another hormone, i.e. progesterin, which causes the changes characteristic of the lutein or secretory phase. The anterior part of the pituitary gland produces two hormones, prolactin A. which effects the ripening of the Graafian follicle, and prolactin B. which stimulates the development of the corpus luteum. The endometrium breaks down—menstruation—on the death of the corpus luteum, which is probably caused by the death of the ovum.

Other endocrine factors which influence menstruation. *The pituitary gland.* In dystrophia adiposogenitalis (hypopituitarism) there is atrophy of the genitalia accompanied by amenorrhœa.

Removal of the pituitary induces genital atrophy; conversely, removal of the ovaries is followed by hypertrophy of the pituitary. Daily subcutaneous transplantation of pieces of the anterior lobe of the pituitary were shown by Aschheim and Zondek (*Arch. f. Gynec.*, 130, 1934) to be followed by œstrus, while the ovaries displayed a vast increase in the number of developing Graafian follicles.

A completely opposite effect was obtained by Evans and Long (*Anat. Record*, 21, 1921), who prepared alkaline extracts of the anterior lobe of the ox pituitary and injected these into the rat. Œstrus was suppressed indefinitely during the time that these injections were made. When the ovaries were examined after this treatment, they were seen to contain large masses of lutein tissue as the result of conversion of the follicular into the lutein cells. No ripening follicles were present. These injections were shown to delay labour indefinitely in the pregnant laboratory animals. Puberty and œstrus were postponed by injections of this substance.

The thyroid gland. Menstruation does not occur in cretins unless they are treated with thyroid. Myxœdema is associated with menorrhagia. As a general rule thyroid activity and menstruation vary inversely, as has been shown by a study of the basal metabolic rate. Certain types of menorrhagia associated with hyperthyroidism, and showing a B.M.R. increase of 25 per cent, were cured by X-ray applications to the thyroid. Experimental removal of the thyroid gland in animals is followed by atrophy of the genital organs.

MENOPAUSE

The *menopause* or *climacteric* is the time of life when menstruation ceases. It usually occurs about 48 years of age, often as late as 52 or 53, rarely as early as 38. Early puberty and late menopause are usually associated.

Symptoms of an unpleasant and often distressing nature are usual, although in certain cases they are slight or even absent.

(a) *Cessation of menstruation* is normally gradual with spells of amenorrhœa. Excessive or irregular bleeding is abnormal.

(b) *Vasomotor disturbances.* Hot flushes and sweating are the most characteristic symptoms, and tend to be periodic and variable in intensity and occurrence.

(c) *Nervous phenomena.* Headaches, often vertical, and attacks of depression also occur periodically.

Changes are: (a) bodily; and (b) genital.

Bodily changes. There is a tendency to obesity affecting the whole body, atrophy of muscles, and wrinkling of the skin.

Genital changes. The *vulva* atrophies and shrinks. The *vagina* shrinks and becomes inelastic, the mucosa becomes pale and atrophied, rugæ disappear, and contraction rings may develop.

The *cervix uteri* shrinks and the vaginal portion disappears. The *corpus uteri* is greatly diminished in size, the muscle being replaced by fibrous tissue. The endometrial stroma almost completely disappears, and the gland elements are greatly reduced in number and size.

The *Fallopian tubes* (the plicæ and fimbriæ) atrophy.

The *ovary* shrinks to about a third of its normal size, is deeply corrugated, its stroma is converted into fibrous tissue, and only a few isolated follicles remain.

DIAGNOSIS

Amenorrhœa may suggest pregnancy, but observation for two months will exclude this possibility.

Irregular uterine hæmorrhage, either as a small loss or prolonged bleeding, may require investigation to exclude carcinoma of the cervix or corpus uteri, or new growth of the ovary in the case of small loss; alternatively, fibroids, or chronic inflammation of the endometrium or pelvic organs where there is prolonged bleeding.

Causes of symptoms are obscure, but are probably due to endocrine imbalance. It is possible that an œstrus-producing hormone, which is responsible for the physical and mental characteristics of the fully mature woman and which also stimulates follicle ripening and corpus luteum formation, persists in the circulation. This theory is supported by the periodicity of the symptoms and by their relief when menstruation or extraneous bleeding from nose or bowel occurs.

TREATMENT

Moderate out-of-door exercise with long intervals of rest and avoidance of worry and strenuous exertion are advisable.

Hot flushes and sweats. The most effectual remedy is venesection, 1-3 oz. of blood being withdrawn from the median basilic vein daily

for three or four days when these symptoms occur. Occasionally one blood-letting suffices. In plethoric cases or in those who have previously menstruated freely 8-10 oz. may be withdrawn. The effect is more pronounced when calcium gluconate (10 per cent) 10 cc. is injected intravenously immediately after venesection.

Digitalis 3-5 minims t.d.s. stimulates a mild contraction of the peripheral arterioles, limiting their sudden dilatation.

Atropine $\frac{1}{100}$ gr. by mouth on retiring, and repeated every 6-8 hours if necessary, will limit sweating.

Headaches and attacks of depression are treated by blood-letting and injections of calcium. Headache may also be relieved by a powder composed of aspirin 10 grs., phenacetin 3 grs., and caffeine 2 grs., t.d.s., to which codein $\frac{1}{2}$ gr. may be added.

Hæmorrhage. Heavy losses during the climacteric are often beneficial, but irregular or prolonged bleeding demands full investigation, including exploration of the uterus. Should bleeding affect the patient's health, it must be treated on the same lines as menorrhagia.

Estrin has had many advocates. It is ineffectual in doses under 100,000 international units weekly. Pituitary extracts given by mouth are useless. Dried thyroid gland, 1-2 grs. daily, is sometimes beneficial in cases of increasing obesity.

Insulin, 3-5 units intramuscularly daily, should be tried when symptoms are severe and prolonged, as this inhibits the production of oestrogenic hormones. Barley sugar, $\frac{1}{2}$ -1 oz. three to four times a day by mouth, should be taken at the same time.

AMENORRHŒA

Amenorrhœa is the absence of menstruation, temporary or permanent. It may be :

(A) *Physiological* before puberty, during pregnancy and lactation, and after the menopause.

(B) *Pathological.* (a) Apparent. (b) Real.

(a) *Apparent amenorrhœa.* In this type menstrual fluid exudes from the endometrium but does not escape externally. The majority of cases are congenital, very few are acquired.

Causes. In order of frequency they are : Vaginal atresia ; incomplete development of the vagina ; or occlusion of the cervix.

- (b) *Real amenorrhœa.* In this condition menstrual blood does not escape from the endometrium.

Causes. (1) *Pelvic conditions.*

- (a) *Congenital pelvic conditions* such as under-development of the uterus.
- (b) *Acquired pelvic conditions.* (i) Removal of the uterus by operation. (ii) Superinvolution of the uterus. (iii) Removal of both ovaries by operation, or destruction of these by inflammation, X-rays, radium inserted into the uterus, or by bilateral tumours.

(2) *General conditions.*

- (a) *Blood conditions*—chlorosis (rarely seen nowadays), pernicious anæmia, and leucæmia. These may cause amenorrhœa or menorrhagia.
- (b) *Wasting diseases*—tuberculosis, diabetes, cachexia due to malignant disease, malnutrition.
- (c) *Toxic agents*—alcohol, morphia, lead (seen in pottery districts).
- (d) *Chill*, such as cold sea bathing or exposure just before a period is due.

(Suppression of menstruation may be attended with severe abdominal pain. Exploratory laparotomy has on occasions been performed in this type of case on the assumption that the condition was one of ectopic pregnancy.)

(3) *Endocrine disorders.*

- (a) *Ovary.* Absence of the ovaries causes amenorrhœa.
- (b) *Pituitary.* Amenorrhœa usually occurs in cases of acromegaly.
- (c) *Thyroid.* In cretinism the genitalia remain in the pre-puberty stage and menstruation never occurs. In myxœdema, contrary to the general belief, there is menorrhagia. Joll (*Diseases of the Thyroid Gland*, 1932) considers that in hyperthyroidism menstruation is usually not altered in the early stages, but as the toxicity increases the menses diminish and often disappear.

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(d) *Suprarenal gland.* Hyperplasia or neoplasia of the suprarenal cortex is associated with diminishing menstruation and finally amenorrhœa. Virilism and hirsutism, in which there is an unnatural growth of hair on the chest, abdomen, thighs, legs and face, occur in certain diseases of the suprarenal gland (see page 3210). Addison's disease is usually accompanied by amenorrhœa.

(4) *Nervous conditions.* Certain nervous disorders such as may be occasioned by fright, shock, prolonged anxiety and hysteria, which are frequently associated with amenorrhœa, are not direct causes but may possibly produce endocrine derangement. Insanity, especially melancholia, is frequently attended by amenorrhœa.

(5) *Other factors.* Changes of residence or of habits of life are frequently followed by amenorrhœa. This is seen in women travelling to distant parts or coming from country places and adopting indoor life.

Diagnosis of causes. *Pregnancy* must in the first place be excluded. By the sixth week clinical findings when taken in combination are usually sufficient to establish a diagnosis with a fair degree of accuracy. The signs and symptoms of early pregnancy are amenorrhœa, morning sickness, and irritability of the bladder; the breasts also become tender with a sensation of weight. On examination the breasts show signs of increasing vascularity and the veins become enlarged and readily visible. The vagina and cervix take on a bluish colour and the cervix becomes soft; the uterus is slightly enlarged, globular in shape and uniformly soft in consistency, and one ovary is slightly enlarged and tender. These findings when taken together confirm a diagnosis of pregnancy. The Aschheim-Zondek or Friedman test will establish or exclude the possibility of pregnancy in 90 per cent of cases.

The next point to which special attention should be paid is the past history, as to whether the patient has previously menstruated, this being followed by amenorrhœa. Previous menstruation excludes the possibility of the amenorrhœa being only apparent, due to atresia of the genital tract or to under-development of the uterus. Amenorrhœa in such a case is most commonly due to pregnancy, and in a much smaller number of cases to anæmia, ill-health, or change of environment.

Other conditions which may cause amenorrhœa are :

(1) *Dystrophia adiposogenitalis* in which there is general sluggishness, mental and bodily, with sterility and an increasing accumulation of fat.

(2) *Early menopause* may occur in women over 35. Here menstruation gradually diminishes, and there are signs of atrophy of the vulva, vagina and uterus.

(3) *Post-pregnancy superinvolution* is characterised by a small uterus and by non-return of menstruation after labour or lactation.

(4) *Rudimentary or infantile uterus*. In such cases the patient has never menstruated.

Treatment of apparent or real amenorrhœa. In cases of apparent amenorrhœa the obstruction must be removed or hysterectomy be performed. Real amenorrhœa is not in itself a harmful symptom, as the patient may be healthy in every way. Certain causes of real amenorrhœa, however, require special treatment, e.g. anæmia.

Under-development of the uterus and superinvolution may be treated with œstrin injections.

IRREGULAR MENSTRUATION

This term is used to designate departures from the normal in rhythm and in the amount of the flow.

(1) *Epimenorrhœa* is a shortening of the cycle from the normal of 28 to 21, or very rarely 14 days. The bleeding may be excessive in amount and the period prolonged (epimenorrhagia).

Classification. There are four types of epimenorrhœa :

(a) *Post-partum*. In this type the shortened cycle appears for the first time after parturition ; usually there is nothing to account for the altered rhythm. The cause is possibly over-activity of the anterior portion of the pituitary gland. There is usually spontaneous recovery, few cases lasting longer than three years.

(b) *Menopausal*. This type occurs at the time of the climacteric, and is usually associated with excessive loss, which may result in severe anæmia. On examination the uterus is often found to be enlarged and firmer in consistency than

normal. This type of case was formerly termed chronic metritis, but present-day knowledge would lead us to believe that both the shortened interval and the increased size of the uterus are the result of increased hormonal activity of the ovaries.

- (c) *Epimenorrhœa complicating fibroids* is usually found at the time of the menopause.
- (d) *The nulliparous type* is encountered in nulliparæ about the age of 35, and is sometimes associated with inflammation of the tubes and ovaries, or with chocolate cysts of the ovary. Usually, however, there is nothing to account for the condition, which must be presumed to be due to endocrine imbalance.

(2) *Hypomenorrhœa* is a condition in which the periods are reduced in number, the cycle being extended to five or six weeks. The recurrence of the periods in such cases is seldom regular, often varying from four to six weeks in the same individual. The loss is usually excessive.

Pathological changes. In many ways these are similar to those described under epimenorrhœa. The uterus usually shows no abnormality; the endometrium, however, may be œdematous and congested, and the ovaries frequently contain hæmorrhagic cystic follicles and corpora lutea, all suggestive of disturbed hormonal activity.

(3) *Oligomenorrhœa* is a condition in which there is scanty menstruation, the periods usually being regular. Puberty is often late in these patients, the menopause early, and the genitalia under-developed, the uterus being of the pubescent type.

Treatment. Irregularity of the periods is not of itself important. Dysmenorrhœa or excessive loss which causes anæmia must be treated.

MENORRHAGIA

This is excessive loss at the period, the duration of which may or may not be prolonged.

Causes. (1) *Inflammations.* Salpingo-oöphoritis and pelvic peritonitis are among the commonest, while endometritis, following post-partum or post-abortion infection and combined with subinvolution, is sometimes a cause.

(2) *New growths.* Fibroids, particularly intra-mural growths expanding the uterine cavity, probably hold second place. Submucous myomata may also cause menorrhagia, but are more liable to be associated with metrorrhagia.

(3) *Displacements.* Retroversion and retroflexion of the uterus are frequently associated with menorrhagia, probably due to disturbed ovarian activity or an associated pelvic inflammation.

(4) *Functional causes.* Menorrhagia often occurs in the absence of any abnormal condition of the uterus. Wilfred Shaw ("Functional Uterine Bleeding," *Jl. of Physiol.*, No. 60, p. 193, 1925) has reported on 200 cases of functional bleeding of this kind, in 17 per cent of which the ovaries were examined and found to be free from any abnormality. Beckwith Whitehouse (*Jl. Obst. and Gynæc. of Br. Emp.*, No. 4, 32, p. 679, 1925) is of the opinion that in these cases there is a deficiency or absence of the thrombokinas which is elaborated in the disrupted endometrium during the menstrual exfoliation.

(5) *Metropathia hæmorrhagica.* The early stages of this condition may be characterised by excessive and regular menstruation in a small proportion of cases; usually, however, the symptoms are prolonged and there is irregular uterine hæmorrhage.

(6) *Endocrine disorders.* (a) *Thyroid gland.* Myxœdema and other degrees of hypothyroidism are often associated with excessive menstrual loss. Increased thyroid activity is occasionally attended by increased loss; usually, however, there is diminished menstruation progressing to amenorrhœa.

Toxic goitre (with increased B.M.R. 18-30 per cent) is attended by intractable menorrhagia in a small number of cases (Joll).

(b) *Pituitary gland.* It is probable that metropathia hæmorrhagica and functional menorrhagia are due to an increase or aberration of anterior pituitary secretion.

(c) *Ovary.* Metropathia hæmorrhagica, in which condition some of the worst types of menorrhagia are seen, is probably due to excessive follicular activity in the absence of corpora lutea.

(7) *Blood conditions.* On very rare occasions thrombocytopenic purpura hæmorrhagica and the leucæmias may cause menorrhagia. Maingot reported several cases (see page 878), and Oldfield (*B.M.J.*, p. 593, March 31, 1934) also records a case.

At the age of *puberty* the onset of menstruation may be attended by pronounced menorrhagia; more often, however, there are spells of floodings and irregular losses, the bleeding occasionally being so severe as to endanger life. This condition is probably due to endocrine imbalance. The approach of the menopause may also be associated with menorrhagia, though here again the losses are liable to be irregular; inco-ordination of endocrine activity is probably the cause.

Investigation of a case of menorrhagia (see page 2195).

TREATMENT

(1) *Rest.* Complete rest in bed during the period is important, together with restriction of strenuous exercise for a few days beforehand.

(2) *Purgatives.* Emptying of the pelvic colon and rectum relieves pelvic congestion; the purgative should produce one or two free evacuations and then leave the bowel quiescent. Pil. colocynthis et hyoscyami, 5-8 grs. at night 48-36 hours before the period is due, will be found beneficial.

(3) *Drugs* are used chiefly to promote uterine contractions; a few have a sedative action, relieving anxiety and probably diminishing blood-pressure, while others promote coagulation. Ergot has long been in use; it contains four active substances, namely, ergotoxin, tyramine, histamine and ergometrine. The last-named of these has a prompt and potent action; ergotoxin has a selective and stimulating effect on uterine muscle but does not act for 15 minutes; and tyramine and histamine stimulate contractions in all unstriated muscle. The best preparation and the one containing ergometrine is the liquid extract of ergot (B.P. 1914), of which 40 minims may be given t.d.s. Ergometrine 0.5 gr. t.d.s. is a potent preparation. Sedative preparations are useful in cases of high blood-pressure and to offset the tendency of ergot to raise intra-arterial tension. Styptol (cotarnine phthalate $\frac{3}{4}$ gr. t.d.s.) and stypticin (cotarnine hydrochloride $\frac{1}{4}$ - $\frac{1}{2}$ gr. t.d.s.) are recommended. Other sedative drugs such as bromides and occasionally opium are useful in very nervous patients. Calcium gluconate, 10 cc. weekly for three or four weeks, promotes coagulation unless blood calcium, normally 9-10 mgms. per 100 cc. of blood, is already high.

(4) *Organic substances.* Extracts of the posterior lobe of the pituitary gland are oxytocic and vasopressor; the former stimulates rhythmic contractions, the latter tonic spasms of the uterus; 5-10 units should be given intramuscularly twice or thrice daily.

Extract of the anterior lobe of the pituitary gland, which is now available and standardised, 100 rat units being given intramuscularly twice weekly or more frequently for two weeks before the period is due, should be tried in cases of functional menorrhagia. This substance stimulates the development of the corpus luteum, the hormone of which—progesterin—has a sedative effect on the uterus and endometrium and inhibits the production of oestrin.

Progesterin, the active substance produced by the corpus luteum, would appear to be the ideal injection; as, however, it is difficult to obtain and preserve it is better to use the anterior pituitary substance to stimulate corpus luteum formation in the ovary.

Insulin, which exerts an inhibitory influence on the production of oestrin, should be given in doses of 2-5 units daily, together with $\frac{1}{2}$ oz. of barley sugar t.d.s., during the interval between the periods.

Thyroid. The dried gland substance in $\frac{1}{2}$ -2 gr. doses should be given t.d.s. if there is a tendency to myxoedema or if there is a definite decrease of the B.M.R.

(5) *Proteins*, foreign or autogenous, may be used; the former may be supplied as horse serum, 2 cc. of which is injected intramuscularly daily for three days preceding the period; the latter consists of whole blood withdrawn from a vein and injected into the gluteus maximus daily for three days before the period, or once a week for several months. The break-down products of these proteins afford a supply of thrombokinase in the circulating blood, thus promoting coagulation.

(6) *Douches.* Vaginal douches, 3-4 quarts of saline as hot as can be tolerated (115°-118° F.) twice or thrice daily, stimulate the contraction of the uterus and arterioles.

(7) *Uterine and vaginal plugging* will usually arrest the severest hæmorrhage.

(8) *Radiation treatment* may be given by means of deep X-ray therapy or radium.

(9) *Operative treatment* includes salpingectomy or salpingo-oöphorectomy for severely inflamed and irreparably damaged tubes and ovaries; ventro-fixation for fixed and retroverted uterus; myomectomy; curettage; utriculoplasty; hysterectomy; or splenectomy (see page 805).

METRORRHAGIA

This is intermenstrual hæmorrhage of any degree.

Occurrence. Metrorrhagia and menorrhagia frequently co-exist and may have a common cause. Metrorrhagia alone may occur with normal menstruation.

Causes. Metrorrhagia is usually due to some local uterine or pelvic condition.

- (1) Local: (a) Uterine: (i) Corpus uteri; (ii) Cervix uteri.
(b) Extra-uterine.
- (2) Endocrine.
- (3) General.

(1) *Local.* (a) *Uterine:* (i) *Corpus uteri.* Fibroids cause metrorrhagia when they are situated immediately below the mucosa, or when polypoid.

Endometrial polypi, which are less than $\frac{1}{4}$ inch in length, cause very slight and irregular bleeding.

Retained products of conception cause intermittent bleeding varying in amount and frequency.

Carcinoma corporis uteri frequently causes post-menopausal bleeding, but never menorrhagia. The bleeding is irregular, varying in amount and frequency, but is seldom profuse.

(ii) *Cervix uteri.* An *adenomatous polypus* is the most common cause of metrorrhagia; the loss is slight, is sometimes brought on by exertion or coitus, and does not tend to increase in amount as time goes on.

Carcinoma. The bleeding is frequently first noticed on coitus and occasionally following exertion; in the early stages there is a blood-stained discharge, later irregular spots of blood, and finally more or less continuous bleeding.

Erosion. On rare occasions an erosion may bleed after coitus, or there may be a slight blood-stained discharge.

Ulceration due to procidentia, pessary, or tuberculosis of the cervix may cause slight bleeding.

(b) *Extra-uterine causes.* Uterine hæmorrhage may be the first symptom of an acute salpingitis or an acute exacerbation of a sub-acute or chronic pyo-salpingitis, or infection of an ovarian cyst.

(2) *Endocrine*. Metropathia hæmorrhagica (see page 2317). Intra-endometrial hæmorrhage seen in women of the child-bearing age is associated with hyperæmia of the endometrium and oozing of blood. It may occur early in the cycle or after secretory hypertrophy has developed.

(3) *General*. An acute febrile condition such as influenza has been known to be associated with sudden hæmorrhage between the periods.

Diagnosis. Intermenstrual bleeding demands full investigation to ascertain the cause, and must always be regarded as a serious symptom until proved otherwise.

Treatment. This should be based upon the cause. Conditions which cause menorrhagia are fully described under their respective titles, together with treatment.

METROSTAXIS

This is hæmorrhage from the uterus before the onset of menstruation or after the menopause.

- (1) Uterine hæmorrhage in the new-born.
- (2) Uterine hæmorrhage in young girls.
- (3) Uterine hæmorrhage after the menopause.

(1) *Uterine hæmorrhage in the new-born*. This consists of a slight oozing a few days after birth; it may last a few hours or days, but always ceases without treatment.

Cause. Nothing definite is known about the cause. It seems reasonable, however, to suppose that the endometrium of the infantile uterus may have undergone hypertrophy as the result of a large amount of œstrin in the maternal circulation. After birth sudden shrinking of the uterus might be expected to follow the complete withdrawal of œstrin, or perhaps even necrosis of the endometrium followed by slight oozing. No treatment is necessary.

(2) *Uterine hæmorrhage in young girls* may be (a) precocious menstruation; or (b) metrorrhagia.

(a) *Precocious menstruation* may conform to one of three types:
(i) Early onset of regularly recurring menstrual bleeding together with

the appearance of secondary sex characteristics. (ii) Early appearance of menstruation with development of the genitalia accompanied by the formation of a tumour in one of the endocrine glands, such as the suprarenal. (iii) Early appearance of menstruation, unaccompanied by other changes of puberty such as secondary sex characteristics.

(b) *Metrorrhagia*. In this condition uterine bleeding occurs with no regularity in time or in amount. There are three possible causes: (i) Trauma as from a fall or attempted rape; (ii) mucous polypus of the cervix: or (iii) grape-like sarcoma of the cervix (sarcoma botryoides), a very rare neoplasm, usually composed of mixed cells, but occasionally cross-striated like striped muscle, i.e. rhabdomyosarcoma. Rounded bluish-coloured masses having the appearance of a bunch of grapes may hang down into the vagina. There is rapid invasion of the cervix, vagina and surrounding tissues, and wide dissemination via the blood stream. The prognosis is hopeless.

(3) *Uterine hæmorrhage after the menopause*. Bleeding may be said to be post-menopausal when it occurs six months after the cessation of menstruation.

Causes. Probably over 50 per cent of cases of post-menopausal bleeding are due to non-malignant conditions. Young, in his work, reports on 155 cases in which 68 (44 per cent) were due to malignant disease. This he regards as a fair average.

In order of frequency the causes are:

- (i) Polypi on the cervix and endometrium.
- (ii) Ovarian tumours (malignant).
- (iii) Carcinoma of the cervix (comprising about 25 per cent of all cases).
- (iv) Fibromyomata.
- (v) Carcinoma of the body of the uterus (about 8 to 10 per cent of all cases).
- (vi) Metropathia hæmorrhagica.
- (vii) Granulosa-celled tumours.
- (viii) Sarcoma of the uterus.
- (ix) Ovarian tumours (benign).
- (x) Tuberculosis of the cervix, uterus or adnexa.

In about 15 per cent of all cases no pathological condition can be found to account for the hæmorrhage. Not infrequently for as long as 10-15 years after the menopause the endometrium is hypertrophied

with enlargement and cystic dilation of the glands. Sometimes necrotic patches can be demonstrated in this thickened mucosa, and at the same time cystic enlargement of the ovary can be palpated (metro-pathia hæmorrhagica). There can be little doubt that the bleeding, which must be regarded as menstrual, can occur many years after the menopause and in women comparatively advanced in years. Fresh corpora lutea and a recently ruptured follicle in the ovary have been observed in elderly women. Beckwith Whitehouse (*Canad. Med. Ass. J.*, Dec. 1933) had one such case, a woman of 67. In connection with this rejuvenescence of the ovary and hyperplasia of the endometrium in a proportion of elderly women, it is interesting to note that in 60 per cent of women after the menopause, prolan has been demonstrated in the urine; hypertrophy of the anterior portion of the pituitary has also been revealed at autopsy. Fertilisation of these late ova has been known to take place. Several cases of pregnancy at ages over 69 have been noted, and one at the age of 74.

Bleeding from the genitalia other than from the uterus is due to carcinoma or tuberculosis of the vulva, caruncle or carcinoma of the urethra, senile vaginitis, carcinoma or tuberculosis of the vagina, or ulceration of the vagina produced by wearing a ring or as the result of prolapse.

Investigation of the case. All cases of post-menopausal bleeding should be examined without delay, and complete investigation should be made to exclude any of the extra-uterine conditions such as those cited. Three malignant conditions must be excluded, namely, *carcinoma of the cervix, of the body of the uterus, or of the ovary.*

Enlargement of one or both ovaries, or resistance in either fornix in the absence of any other condition in the genital tract to account for the bleeding, demands abdominal exploration because of the frequency with which post-menopausal bleeding is associated with either carcinoma or granulosa-celled tumour of the ovary.

Treatment. In cases where the abdomen is opened on the assumption that the ovary is the cause of the bleeding, if there is the least doubt about the condition of the ovaries it is safer to perform bilateral salpingo-oöphorectomy and total hysterectomy.

DYSMENORRHŒA

Dysmenorrhœa is pain associated with menstruation. This pain recurs more or less in the same form and at the same time each month.

Eighty per cent of women have discomfort of some degree. The term would only apply when the pain is so severe as to interfere with the patient's work or pastimes. As pain is a subjective symptom its intensity is extremely difficult to gauge.

Classification. Scientific classification of the varieties of dysmenorrhœa cannot be made; for clinical purposes, division into the following groups is, however, useful:

- (i) Primary (intrinsic).
- (ii) Secondary (extrinsic).
- (iii) Membranous.

Primary dysmenorrhœa is the commonest type and is usually seen in young nulliparous patients; it is essentially menstrual in that it occurs with the onset of the flow or just before it. Typically the pain is felt in the lower abdomen, usually centrally, frequently radiating around the pelvis and down the thighs; less commonly sacral backache may accompany the abdominal pain or may occur by itself.

Character of the pain. This may be: (a) continued aching; (b) spasmodic; or (c) a combination of the two types. The commonest variety is continued aching accompanied by sharp spasmodic or gripping pains. Next in frequency is continued aching alone; it is rare for spasmodic pain only to occur.

Duration. The aching pain generally persists during the first and occasionally also during the second day, but rarely lasts throughout the period. The sharp spasmodic attacks continue for a few minutes to an hour, seldom longer, and usually occur at the onset of the flow.

In the majority of cases menstruation is painless until about the age of 17 to 19, but occasionally aching pain may be felt from puberty. There is a tendency for the pain to become more pronounced as the patient gets older, until about the age of 30 when it again diminishes; it is rare to encounter the spasmodic type after the age of 35. There appears to be a natural process of cure which brings relief after this age. Pregnancy cures most cases of primary dysmenorrhœa.

It is common to find that where puberty is late in onset menstruation is scanty, the flow increases as the pain diminishes, the period is short, lasting only one or two days, and the menopause is reached unusually early; in such cases sterility is also common.

Pathology. In many patients no abnormality can be discovered. Frequently, however, there is general under-development of the genitals—the vagina is narrow and short, and the uterus is of the small adult type and cochleate, or, as I have often noted, long with slim lower segment and globular fundus. In the former type there appears to be an increased proportion of fibrous tissue, especially surrounding the internal os.

Causes are obscure. Pain originates in the uterus as is evidenced by the fact that hysterectomy will cure the condition.

Endometrial thickening from pre-menstrual congestion, causing colicky spasm and disturbed polarity in which the lower segment contracts simultaneously with the fundus, producing obstruction, is a popular theory. Irregular action due to incomplete development of the normal neuro-muscular mechanism is the most probable cause, as this type of dysmenorrhœa is so commonly associated with an under-developed uterus.

Treatment :

- (1) Hygienic.
- (2) Endocrine.
- (3) Medicinal.
- (4) Operative : (a) Injections. (b) Dilatation and Curettage. (c) Hysterotomy. (d) Presacral Neurectomy. (e) Hysterectomy.

Hygienic. The adolescent girl should be taught that menstruation is a natural function and a normal condition of healthy life, not something to be regarded with either fear or disgust.

Pain is very much relieved and frequently forgotten by healthy recreation and pastimes, outdoor life, sufficient sleep, and the avoidance of over-exertion. It is important to treat constipation ; a loaded rectum and sigmoid colon greatly add to pelvic congestion. The bowel should be thoroughly emptied beforehand, an excellent purgative for this purpose being pil. colocynth. et hyoscyam. 5 grs. at night 72 to 48 hours before the onset of the period. This purgative will produce one or two actions, and leave the bowel quiescent afterwards. Physical exercises are to be recommended, especially those which develop the muscles of the pelvic floor, abdomen and back.

Endocrine. In all cases where the development of the genitalia is below normal, the uterus being of the small adult type, retroverted,

retroflexed, or of the long slender variety, œstrin should be injected. As previously stated the uterus can be brought up to a normal state of development by the use of this hormone, if the dosage is sufficient.

Medicinal. Anodyne drugs used for the relief of pain are very numerous, the salicylates and the coal tar derivatives being among the most popular. The following prescription is useful :

Acid acetylsalicyl.	10 grs.
Phenacetin	10 grs.
Caffein citrate	5 grs.

This may be given in cachet form 6-hourly for three days. It is preferable to give it with a hot drink, which is in itself to some degree soothing and which also hastens the absorption of the drugs. Sharp spasmodic pain can usually be relieved by an injection of atropine, $\frac{1}{160}$ gr. This type of pain may be very severe, but it seldom lasts longer than an hour. If the time of onset can be estimated atropine, $\frac{1}{8}$ - $\frac{1}{16}$ gr. by mouth, should be taken. On no account must opium or its alkaloids be given, as addiction to this drug may be acquired.

Operative.

(a) *Injections.* Infiltration of the region of Frankenhäuser's plexus with 85 per cent alcohol, 3 cc., should be tried. The needle is passed through the vaginal vault about $\frac{1}{2}$ inch lateral to the side of the cervix to a depth of about $\frac{3}{4}$ inch ; this can be repeated if the pain is not relieved or if it recurs.

(b) *Dilatation and curettage* will cure about 5 per cent and give relief to another 20 per cent of cases. In severe cases the injection treatment should be given at the same time.

(c) *Vaginal hysterotomy* is said to be more effectual than dilatation, but is, of course, a much bigger undertaking. It is also an exceedingly difficult procedure in a patient with an under-developed and narrow vagina.

(d) *Presacral neurectomy* was first suggested by Jaboulay in 1891 and re-introduced by Cotte in 1925. It is a very satisfactory operation, and has to a great extent replaced other procedures such as hysterectomy. (See page 3201.)

(e) *Hysterectomy* will always cure dysmenorrhœa ; it must, however, only be performed where other measures have failed to give

relief; where the pain is particularly severe and unbearable; or in patients who have to earn their living and for whom a few days absence from duty each month is impossible.

SECONDARY DYSMENORRHOEA

(Congestive, extrinsic, or premenstrual)

Secondary dysmenorrhœa is pain associated with menstruation and often premenstrual in onset; it is essentially an acquired symptom due to some pelvic lesion.

Character of the pain. The pain is always constant and aching, and is aggravated by exercise, exposure to cold, and constipation; it is nearly always relieved when the flow is well established.

Site. The pain is usually felt in the hypogastrium, the sacral region, and radiating down the thighs. Occasionally it is more pronounced on one side.

Time. The pain always precedes the menstrual flow, frequently by as much as a week, and seldom lasts longer than the first day.

Concomitant symptoms. In many patients there is accompanying headache and general malaise which also decrease as the flow becomes free. Menorrhagia is a common accompaniment. Between the periods there is often pelvic pain, a feeling of weight and "bearing down," the patient feels indisposed and suffers from mental depression; some patients will say that their most comfortable time is when the period is well established and for the first few days after its cessation. In many instances the condition follows an abortion, parturition, or an acute attack of salpingo-oöphoritis.

Causes. The commonest causes are pelvic inflammations, especially chronic salpingo-oöphoritis, pelvic cellulitis, and chronic endometritis; also retroversion of the uterus with prolapsed ovaries, and occasionally tumours such as fibroids or ovarian cysts lying in the pelvic cavity.

Treatment should aim at the removal of the cause where possible. Much relief can be obtained through alleviating pelvic congestion by evacuation of the rectum and sigmoid colon and by copious hot douching for two days before the period is due. Rest in bed, or avoidance as far as possible of exertion, hot douches night and morning, and

hot hip baths for ten or fifteen minutes each night before retiring are advised for relief of the pain. Drug treatment for relief of pain is the same as that advised for primary dysmenorrhœa.

MEMBRANOUS DYSMENORRHŒA

(Menstrual Exfoliation)

This is a comparatively rare form of dysmenorrhœa which is accompanied by the passage of casts from the uterus. Typically, before the period there is aching pain which increases in severity, becoming spasmodic and colicky until a mass (a cast) is passed from the uterus, after which the pain suddenly ceases and the flow, which was at first scanty, is established.

Casts. Stevens states that there are two types of casts: (i) the solid, and (ii) the hollow triangular.

The solid uterine cast is much the commoner, resembling the uterine cavity in shape, and consisting microscopically of a fibrillated stroma containing leucocytes, red blood cells, and shreds of endometrium.

The hollow triangular cast is flattened from before backwards about 1 inch wide at the base, the walls being about $\frac{1}{8}$ inch thick, smooth and dimpled on the inside, and rough and shaggy on the outside. Microscopically it consists of stroma cells, glands, and extravasated blood. No decidual cells are seen.

Diagnosis. This type of dysmenorrhœa can be distinguished from the primary or spasmodic variety by the pronounced character of the pain which suddenly ceases upon the passage of a cast. *The cast must be distinguished from:*

(1) *The decidual cast of ectopic gestation*, which is seen microscopically to be composed entirely of large decidual cells and uterine glands.

(2) *Products of conception.* Microscopical examination will reveal blood clot, decidual cells, and the characteristic chorionic villi in large numbers.

(3) *Blood clot.* This is seen under the microscope to consist of a fibrinous mesh with red and white corpuscles. No decidual cells, chorionic villi, stroma cells, or uterine glands are visible.

Causes. Nothing definite is known as to how these casts are formed or why they are shed. In the solid type the microscopical appearance

suggests that the extravasated blood coagulates in the superficial layers of the endometrium instead of escaping as fluid into the uterine cavity; this coagulated blood then becomes a foreign body and is expelled by uterine contractions, stripping off in the process the superficial part of the endometrium with which it is incorporated. Patients of any age may be affected. The condition has been known to appear for the first time after miscarriage or labour. Many such patients, however, are sterile. Pregnancy is not a natural cure as is the case in primary dysmenorrhœa. The condition is not harmful in itself, and treatment is required only for the relief of pain.

Treatment is the same as for primary dysmenorrhœa. Drugs, especially injections of atropine $\frac{1}{100}$ gr. just before the spasm reaches its greatest intensity, will occasionally ease the pain. Estrin or other hormones in adequate dosage have not to my knowledge yet been given a trial. Curettage is said to cure a very small percentage of cases or bring relief for a time. Injections of alcohol into Frankenhäuser's plexus should be given, and repeated if necessary. If this is not successful then presacral neurectomy is indicated. Where even this fails, radiation may be advised, or, better still, hysterectomy.

INTERMENSTRUAL PAIN

(Middle pain, or Mittelschmerz)

This is pain recurring regularly between the periods. Pain of an aching nature is felt in the lower abdomen and sacral region, and lasts about a week, beginning about 10–14 days after the onset of menstruation.

Causes are not known. It is usually an acquired condition, seldom arising at the time of puberty. Single and married, nulliparous and parous patients seem all to be equally affected, and it has been known to occur for the first time after labour. Exploration of the abdomen may show the pelvic organs to be normal; chronic salpingo-oöphoritis, however, is not infrequently associated with the condition, and occasionally there is retroversion of the uterus with prolapse of the ovaries. Rhythmicity of the condition and its occurrence about the time of ovulation suggest ovarian origin. Sclerosis of the surface of the ovaries making dehiscence of the ovum difficult and painful has been suggested as a possible cause.

Treatment. Examination should be made for evidence of pelvic inflammation or displacement of the uterus with ovarian prolapse, and appropriate operations performed; otherwise treatment is on the same lines as for dysmenorrhœa. When the abdomen is opened to deal with retroversion or prolapse of the ovaries, presacral neurectomy may occasionally be indicated.

ANOMALIES OF PREGNANCY

ABORTION

Abortion is the premature expulsion of the embryo. The condition probably belongs more strictly to the field of obstetrics, but is so frequently encountered that it is one of the commonest conditions with which the gynecologist has to deal.

Causes :

Uterine congestion due to displacements such as retroversion, to retroflexion, fibroids (especially submucosal), and to salpingo-oöphoritis. Engorged capillaries rupture when fright or accident causes an increase of blood-pressure. Bleeding when once started tends to spread and separate the chorion from the decidua. When a clot forms it acts as a foreign body stimulating uterine contractions which eventually expel the embryo.

General diseases attended by marked pyrexia, such as the specific fevers, are frequently followed by abortion. The toxæmia which produced the fever is probably responsible for the death of the fœtus which is subsequently expelled. Nephritis, either as the acute "pregnancy kidney" or as the chronic variety with raised blood-pressure, is a very common cause. Cardiac failure and cirrhosis of the liver may cause increased congestion and engorgement of the capillaries in the endometrium with subsequent hæmorrhage. Diabetes mellitus, tuberculosis, or anæmia is occasionally responsible for the death of the embryo.

Accidents such as a fall, fright, or anxiety can only cause abortion by raising blood-pressure with occasional chorionic hæmorrhage.

Deep lacerations of the cervix are sometimes associated with abortion.

Abortions before the 20th week are never due to syphilis. After this stage the disease frequently produces infarction in the fully-developed placenta with the consequent death of the fœtus.

Repeated abortions are common, the usual cause being under-development of the uterus.

Prognosis. After three or four abortions the patient usually goes to full term with normal subsequent pregnancies.

Treatment is operative or by means of endocrine extracts.

Operations are performed for repair of cervical lacerations, removal of fibroids, and correction of displacements, while dilatation and curettage may also be deemed necessary.

Endocrine treatment. This consists of injections of œstrin to bring the uterus up to a normal state of development, and the use of a luteinising hormone such as antuitrin S, 100 rat units of which are injected twice weekly, beginning as early as possible after the first period is missed and continuing to the 20th week of pregnancy. This promotes growth of the corpus luteum, which again manufactures a hormone (progesterin) which has a sedative action on the uterus and inhibits follicular ripening and production of œstrin. The patient should also be kept in bed for two or three days at the time of the suppressed periods as there is an increased tendency to hæmorrhage at this time.

For clinical purposes abortion may be grouped into :

- (1) Threatened.
- (2) Inevitable.
- (3) Incomplete.

(1) *Threatened abortion* is characterised by uterine hæmorrhage of varying degree and slight pelvic pain. A history of amenorrhœa for two, three, or four months, accompanied by symptoms and signs of pregnancy, can usually be obtained. The os uteri is always closed.

It is important in all cases of threatened abortion to exclude the possibility of extra-uterine gestation.

In ectopic gestation the pain is always severe and continuous with frequent exacerbations. Bright red blood and clots are seldom passed. Usually the loss is slight, being more in the nature of a brownish discharge. A decidual cast is passed in about 20 per cent of cases. It is never infiltrated with blood clot, but is white, thick, and smooth and shining on its inner surface. Microscopic examination will show it to consist of masses of decidual cells without any evidence of chorionic villi which are invariably present in intra-uterine pregnancy. The patient, too, is very ill, the pulse tends to be rapid, and there may be symptoms of internal hæmorrhage. There is marked tenderness in the hypogastrium and vaginal fornices.

Carcinoma of the cervix is a rare but possible complication of early pregnancy, and one which demands careful examination with a speculum in all cases.

Treatment. Absolute rest in bed and the administration of sedative drugs, morphia $\frac{1}{4}$ gr., should be given twice daily for three days while the patient is kept under observation. The following mixture may also be given a trial: Sodium bromide 15 grs. with tinct. hyoscyam. 40 minims t.d.s. for three days. Antuitrin S 100 r.u. daily until bleeding has ceased may also be found beneficial.

(2) *Inevitable abortion* is characterised by all the symptoms and signs of abortion together with dilatation of the os uteri, so that some part of the embryo may be felt within the cervical canal. Hæmorrhage is usually profuse. The condition must be distinguished from a fibroid in process of extrusion or a chronic inversion of the uterus. Neither of these conditions is attended by symptoms and signs of pregnancy, nor is there a history of amenorrhœa.

Treatment consists of rest in bed with strict supervision; no active steps should be taken unless complications arise. In the majority of these cases there is spontaneous and complete evacuation of the uterus. The complications which may require treatment are hæmorrhage and sepsis.

Hæmorrhage is very common. It is often free and is sometimes severe enough to cause a pronounced degree of anæmia and collapse. The death-rate from hæmorrhage, however, is very low, less than 1 in 500. Bleeding tends to stop spontaneously, but if persistent, it can usually be arrested by an intramuscular injection of pituitrin 1 cc., together with ergotamine tartarate $1\frac{1}{2}$ gr., or by one of the other preparations of ergot. Liquid extract of ergot 1 drachm by mouth is most effectual. As an additional measure the vagina may be packed with a roll of gauze soaked in eusol or glycerine.

When there is much collapse heat is applied, the head is lowered, and restlessness and distress are allayed by a hypodermic injection of morphia $\frac{1}{4}$ gr. with atropine $2\frac{1}{2}$ gr. An intravenous infusion of 30 oz. of normal saline, gum saline 6 per cent, or glucose solution 10 per cent to which may be added insulin 5 units may be given. 500 cc. of citrated blood may be transfused and may possibly help to raise the patient's resistance to infection.

Sepsis is a serious complication and is the usual cause of death.

(3) *Incomplete abortion* is the retention of all or part of the membranes. When seen early it presents the same symptoms and signs as inevitable abortion. Occasionally the cervix is sufficiently dilated to admit a finger, when the retained membranes can be felt. Bleeding is sometimes free and the uterus is enlarged, soft, and globular in shape.

The nature of the condition is obvious when an embryo has been passed; otherwise the diagnosis must be made on the history of amenorrhœa and symptoms of pregnancy together with the physical findings on examination. There is always the menace of sepsis.

Treatment. When seen early the uterus should be encouraged to expel its contents by the administration of pituitrin 1 cc. intramuscularly every 4 hours for six doses. Liquid extract of ergot 1 drachm t.d.s. is given at the same time. This treatment may be repeated after an interval of 24 hours and usually results in evacuation of the uterus.

When these efforts fail and the patient has been under observation for five or six days without symptoms of fever, the uterus remaining large and soft and bleeding being slight but persistent, then digital evacuation is advised.

Septic abortion. Sepsis, as already mentioned, is a serious complication and almost the only cause of death in such cases; recovery is usually followed by much ill-health. Sepsis is often the result of an attempt to procure abortion. Pathologically it is identical with puerperal sepsis, and the following complications may occur: endometritis, salpingitis, peritonitis, pelvic cellulitis, thrombophlebitis, pyæmia, or septicæmia. Salpingitis and peritonitis of a severe nature are more commonly seen in septic abortion than in puerperal sepsis. High fever is frequently associated with infection of retained products of conception (incomplete abortion). The streptococcus is the usual causative organism. Sepsis complicating abortion must be distinguished from pyelitis, which may also follow abortion and be attended by marked pyrexia. A bacteriological examination of the urine will prove the presence or absence of pyelitis.

In all cases a bacteriological examination of the interior of the uterus should be made.

Treatment is conducted on the same lines as for puerperal sepsis, repeated blood-transfusions being given and glycerine injected into the cavity of the uterus. A large gum elastic catheter is passed

into the uterus up to the fundus and left *in situ*. Glycerine 2 drachms is then injected very slowly every two hours. No attempts should be made to remove retained products when there is any degree of pyrexia. Glycerine treatment, as just described, is carried out until the temperature returns to normal, after which an interval of 10-14 days must be allowed before evacuating the uterus.

Persistent hæmorrhage following abortion. Continuous bleeding following an abortion, and without a free interval, is indicative of the retention of the products of conception. The first period after an abortion is almost invariably profuse. A type of case frequently seen is that in which bleeding as a continuous daily loss, rarely excessive in amount, persists for several weeks. Similar cases are sometimes seen after normal delivery.

The cause of this bleeding may be subinvolution, endometritis, retroversion of the uterus, deficiency of blood calcium, or functional disorder—metropathia hæmorrhagica. A cystic ovary is frequently palpable and the endometrium may show areas of necrosis.

The condition must be distinguished from retained products and chorionic carcinoma. In the case of retained products the uterus is bulky and soft, and the cervix is sometimes sufficiently patent to admit a finger; in chorionic carcinoma, a rare sequel of abortion, bleeding is free and purple nodules may be detected in the lower part of the vagina. Confirmation of the presence of chorionic carcinoma may be afforded by the Aschheim-Zondek or Friedman test.

Treatment is the same as for menorrhagia.

MOLE

Another anomaly of pregnancy is the formation of a mole, either carneous or hydatidiform.

Carneous mole (missed abortion) is an infrequent condition constituting only 1 per cent of all cases of abortion. The ovum usually dies between the 8th and 10th weeks, but is not immediately expelled. Repeated hæmorrhages occur into the chorion and decidua. The amniotic sac can as a rule be seen in the centre of the mole, surrounded by laminæ of compressed clot. The causes are unknown and the uterine tolerance of this "foreign body" is also obscure.

Symptoms. Slight bleeding usually occurs at the time of the death of the embryo, followed by a long period of amenorrhœa. Sooner or later bleeding and discharge, sometimes attended by pains, start

again as the uterus attempts to empty itself, which it invariably does spontaneously in due course. The period of amenorrhœa may last for several months and on occasions for as long as two years. The uterus is found to be as large as that of a six or eight weeks' pregnancy but much firmer in consistency. The cervix is slightly softened, and Hegar's sign is absent.

Where the typical history is present—a period being missed, then a slight hæmorrhage followed by a long spell of amenorrhœa—the diagnosis presents no difficulty. Difficulty may, however, arise where the patient has miscarried at the time of the initial hæmorrhage, and again become pregnant; in the latter case the symptoms and signs of normal pregnancy will be present. Hegar's sign will probably be noted, and if the case is watched for a month, increase in size and softness of the uterus can be detected.

Treatment. Patients frequently insist on evacuation of the uterus, and if bleeding and foul discharge are present delay is not advisable. Medical treatment which is often successful should first be tried; quinine bihydrochloride, 5 grs. (in capsules), 3-hourly for four doses, and extract ergot liq., 1 dr., are given, and pituitrin, 1 cc., is injected 4-hourly for four doses. Hot douches of dettol 1 drachm to a quart should be given t.d.s., and after the second dose of quinine, $\frac{1}{2}$ oz. of castor oil is administered. This scheme of treatment may be repeated every second day for a week.

Operative treatment consists in the insertion of three or four dry sterilised *laminaria tents* into the cervical canal. Treatment with pituitrin and ergot is carried out at the same time, and evacuation usually takes place within 48 hours.

Another method is to dilate the cervix and pack the lower uterine segment with gauze soaked in glycerine containing 2 per cent iodine. The vaginal vault is also tightly packed, and pituitrin and ergot given. The packs are removed in 24 hours, by which time the mole will probably have been expelled into the vagina. These methods are safer than wide dilatation of the cervix and immediate evacuation.

Hydatidiform mole, or hydatidiform degeneration of the chorion, is a change which affects the growing embryo very early, probably as soon as the villi become vascularised (fig. 1179). It is essentially the result of an excessive proliferation of both the syncytium and Langhans' cells; the connective tissue of the villi, being unable to keep pace with the growth of the trophoblast, consequently becomes œdematous.

The villi thus increase enormously in size and swell out in an irregular manner, resembling a string of beads or a bunch of grapes.

The *cause* is not known. Excessive growth of lutein tissue is almost invariably associated with hydatidiform mole, and in about 50 per cent of cases there are large corpus luteum cysts. These quickly disappear after expulsion of the mole.

Symptoms and Signs. The most characteristic sign is enlargement of the uterus greatly in excess of the duration of the pregnancy, e.g. the

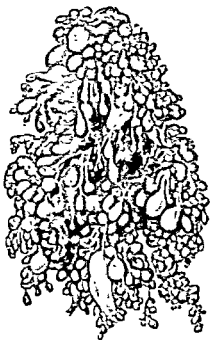


Fig. 1179.—HYDATIDIFORM MOLE. THE CHORIONIC VILLI ARE CONVERTED INTO CHAINS OF VESICLES OF VARIABLE SIZES. BLOOD CLOT HAS BEEN REMOVED. (ONE THIRD OF NORMAL SIZE.)

fundus uteri may be up to the umbilicus with a history of twelve weeks' amenorrhœa. On rare occasions there is little appreciable increase in the size of the uterus. When there is enlargement it is partly due to cystic expansion of the villi and partly to retained blood clot. Continuous bleeding occurs sooner or later and may quickly produce marked anæmia. The patient looks ill, drawn and anxious, and her appearance suggests toxæmia in addition to anæmia.

Pain is a common symptom, and is usually continuous with intermittent exacerbations.

On examination the enlarged uterus feels doughy and occasionally irregular in consistency. If a characteristic vesicle is passed, the diagnosis is then assured.

Results. Spontaneous expulsion of the mole is usual and may occur early, i.e. after a few hours or days of pain and bleeding, or may be delayed for several weeks. A very important sequela is the development of chorionic carcinoma, and more than half of these cases follow hydatidiform mole. This malignant change may take place while the mole is still in the uterus, or arise several weeks or months after evacuation.

Treatment. When the diagnosis is established the uterus should at once be emptied. Normal involution quickly follows and the bleeding ceases in a few days. The Aschheim-Zondek or Friedman

test should be carried out in a month's time to determine whether or not any chorionic tissue is still growing.

DISPLACEMENTS

Descent or prolapse of the uterus is fully described under Diseases of the Vagina. (See page 2241.)

Backward displacement—retroversion and retroflexion (fig. 1180). The fundus of the uterus may be turned backwards with the cervix directed

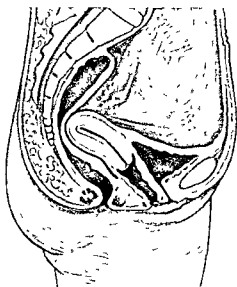


Fig. 1180.—RETROVERTED UTERUS.

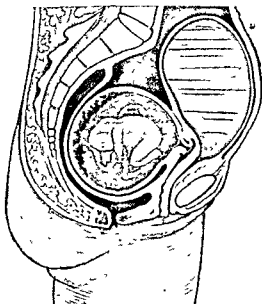


Fig. 1181—INCARCERATION OF A RETROVERTED GRAVID UTERUS. THE FUNDUS REMAINS IMPRISONED BY THE PROMONTORY OF THE SACRUM, AND THE CERVIX IS TURNED UPWARDS AND FORWARDS COMPRESSING AND ELONGATING THE NECK OF THE BLADDER WHICH IS GREATLY DISTENDED

forwards—retroversion, or it may be bent backwards with the cervix pointing backwards or downwards—retroflexion. The former is slightly more common, the latter often being associated with some degree of under-development of the uterus. Both may be congenital or acquired.

Congenital retroversion is frequently found in virgins and nulliparous women, the uterus occasionally being of the small adult type.

Treatment. None is required for the retroversion except when it causes dysmenorrhœa, sterility, or repeated abortions.

If, however, the condition is discovered when performing an

appendicectomy for sub-acute or interval cases, Gilliam's operation should be performed.

Acquired retroversion and retroflexion. The chief causes are pregnancy and the dorsal position in the lying-in period. As the result of the former all the ligaments and supports are softened and relaxed, whilst the latter allows the bulky uterus to fall backwards.

Other conditions producing retroversion are adhesions and tumours. Adhesions result from an attack of salpingo-oöphoritis or pelvic peritonitis, and as the result of organisation of plastic lymph, they occur between the tubes, ovaries, back of the uterus and the pouch of Douglas, the uterus being gradually drawn backwards towards the rectum. Occasionally the inflammation may anchor a uterus which is already retroverted.

Fibroids growing in the fundus, especially in the posterior wall, or ovarian cysts may also by their weight bring about this condition. Retroversion is never due to an accident or fall.

Symptoms may be slight or absent. The most common, however, are lassitude, backache, and a feeling of weight and "bearing down" in the pelvis, especially after walking and standing.

Menorrhagia, dysmenorrhœa due to congestion of the uterus, leucorrhœa, or dyspareunia are also fairly constant symptoms.

Diagnosis. A careful bimanual pelvic examination should reveal the condition.

Prolapse of the ovaries also frequently occurs, causing aching pelvic pain, dysmenorrhœa, or dyspareunia.

Another complication is incarceration of the retroverted uterus when gravid, causing difficult micturition and finally retention of urine (fig. 1181).

Other complications are salpingo-oöphoritis, fibroid, and ovarian tumours.

Treatment. Backward displacement without symptoms requires no treatment. This applies specially to unmarried women with the congenital type of retroverted uterus; indeed, it is unwise even to inform these patients of the presence of the condition. In this type the uterus could not be maintained in a forward position even if it were secured by instrumentation under anæsthetic. Treatment is required for the relief of pelvic pain, backache, menorrhagia, dysmenorrhœa, and dyspareunia.

Anteversion and Antelexion. Anteversion with a very small degree of antelexion is the normal position of the uterus. Antelexion which may be pronounced and associated with symptoms is divided into two types :

Congenital type (cochleate uterus) is usually associated with under-development (see fig. 1177).

Acquired type, due to contraction of the cervico-pelvic ligaments as the result of cicatrization following acute cellulitis or chronic inflammation secondary to a chronic cervicitis, causes pelvic pain, dysmenorrhœa, and occasionally dyspareunia.

Treatment consists of hot douches and diathermy.

Lateral displacement may be due to pressure of a broad ligament cyst, to a fibroid, or to cicatricial contraction resulting from cellulitis.

Treatment consists of the removal of the cyst or fibroid, and the relief of pain in the cicatricial tissue by hot douches and rectal diathermy.

INVERSION OF THE UTERUS

This is a very rare condition and, strictly speaking, is not a displacement. It may be *acute* or *chronic*, and either complete or incomplete.

Acute inversion, which is usually complete, occurs during or after the third stage of labour. It is generally spontaneous, but may be caused by pulling on the cord while the placenta is still attached, or by dipping the fingers into the top of the still flaccid fundus uteri in an attempt to express the placenta.

Occasionally puerperal inversion is incomplete. The condition is then less serious and can easily be dealt with, but may escape detection.

Symptoms. Acute puerperal inversion is attended with pain, hæmorrhage and collapse. Shock is severe and out of all proportion to the amount of blood lost. On examination a dark red or purple mass, pyriform in shape and narrowing towards the upper end, may be found in the vagina or protruding from the vulva. The rough placental site and occasionally the tube orifices may be seen. At the upper end the tight constricting ring of the cervix (which seldom everts) can be seen and felt. The condition is very serious, the mortality being

about 65 per cent. The patient may die immediately of shock and hæmorrhage, or subsequently from sepsis.

Treatment. No immediate attempt at reposition should be made. The vagina should be packed with gauze soaked in warm eusol to

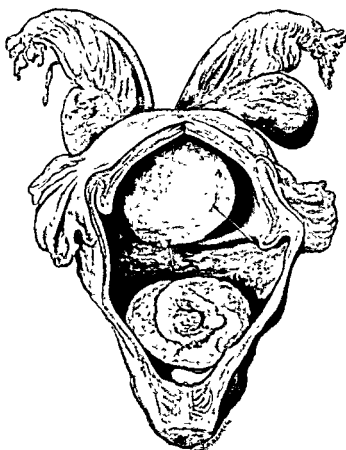


Fig 1182.—INVERSION OF THE UTERUS. THE ANTERIOR WALL OF THE UTERUS, CERVIX, AND VAGINA HAVE BEEN LAID OPEN, SHOWING THE INVERTED FUNDUS COMING THROUGH THE DILATED CERVIX. WITHIN THE VAGINA LIES A PEDUNCULATED FIBROID WHICH HAD BEEN CUT FROM THE FUNDUS AND WHICH WAS PROBABLY THE CAUSE OF THE INVERSION. THE OPENING OF THE FALLOPIAN TUBES ARE INDICATED BY TWO BRISTLES. THE MEDIAL ENDS OF THE FALLOPIAN TUBES AND OVARIO-UTERINE LIGAMENTS CAN BE SEEN DIPPING DOWNWARDS INTO THE CRATER FORMED BY THE INVERSION (Mss, R.C.S.)

arrest hæmorrhage, and the patient treated for shock. Blood-transfusion should be given where possible, and especially if there has been serious hæmorrhage (see page 2544).

Chronic puerperal inversion may be complete or incomplete. It may be recognised within a few days of labour or escape detection for several months. The everted uterus may occasionally become infected

and ulcerated, and sloughing areas due to pressure of the vaginal walls or constriction of the cervix may be produced, giving rise to a purulent discharge.

The *symptoms* are pelvic pain, bleeding, discharge, and sometimes fever due to toxæmia. On examination the inverted fundus is found in the vagina or protruding externally, and on bimanual examination the uterus is absent from its normal position and a cup-shaped depression is felt in its place. If the case is of some standing the condition must be distinguished from a fibroid in process of extrusion. In the case of inversion the passage of a sound will reveal foreshortening of the uterine cavity. Difficulty will arise where there is partial inversion of the uterus together with a fibroid in the inverted fundus. The cavity is also foreshortened, but the rounded firm tumour can usually be identified by careful palpation.

Treatment. An attempt may first be made to evert the turned-in fundus with an Aveling repositor. The most satisfactory treatment, however, is operative (see page 2545).

A fibroid, or on extremely rare occasions a sarcoma, growing from the fundus may cause inversion, the tumour being extruded by muscular contraction. The usual process, however, is extrusion without inversion.

INFECTIONS OF THE CORPUS UTERI

Acute septic endometritis may be :

- (1) Puerperal or post-abortion.
- (2) Gonococcal.

Gonococcal endometritis is due to invasion of the endometrium by the diplococcus intracellularis. This infection ascends from the cervix by direct continuity of surface and may follow an acute attack or an infection of long standing ; sometimes it follows a menstrual period or occurs after labour or abortion.

Symptoms. The stage of onset is seldom recognised. Intra-menstrual uterine hæmorrhage or an increased loss at the period is often the first indication. There is usually backache and pelvic pain, and there may be slight fever. Sometimes these symptoms are more marked, resembling acute septic endometritis. On examination there are usually signs of gonorrhœa, either pus in the urethra, or mucopurulent discharge from the cervix indicating an erosion. The uterus

may be tender to bimanual compression. The condition must be distinguished from the hæmorrhage of early pregnancy and that attending acute salpingitis. There will be no amenorrhœa or delay in the onset of menstruation, as is almost invariable in pregnancy.

In acute salpingitis the symptoms are more marked, and there is tenderness in the hypogastrium and fornices, whereas in acute endometritis the uterus alone is tender.

Treatment. Rest in bed is indicated. The cervix should be swabbed with 10 per cent picric acid in absolute alcohol and dilated sufficiently to admit a No. 6 rubber catheter. This is then stitched to the anterior lip of the cervix and 2 dr. of glycerine are run into the uterus every 4 hours for four days.

Chronic Endometritis.

There is a very small group of cases in which a true chronic inflammation of the endometrium is found. The condition is, however, believed to follow acute septic or gonococcal infection. Much of what was formerly called endometritis is now regarded as endometrial hypertrophy due to endocrine dysfunction. Microscopical examination of endometrium removed with the curette exhibits a wide range of appearances, depending upon the stage of intermenstrual growth reached when curettage was performed. The most characteristic findings appear to be endometrial thickening and leucocytic infiltration. The endometrial hypertrophy is probably due to the normal change which precedes menstruation. Leucocytic infiltration is seen in small areas of the endometrium in which there are nests or groups of polymorphonuclear leucocytes or numbers of large ovoid plasma cells, the protoplasm of which contains numerous granules staining with eosin.

Symptoms. There is often menorrhagia, leucorrhœa, and backache, and in some instances sterility and a tendency to repeated abortions. The uterus is occasionally enlarged to a slight degree and tender to pressure. The leucorrhœa is due to an associated cervicitis.

Treatment is palliative or operative. Palliative treatment is the same as that described under menorrhagia (see page 2292). Operation consists of curettage and swabbing of the uterus with an antiseptic such as 10 per cent picric acid in absolute alcohol.

Senile Endometritis.

This is a septic infection of the uterine cavity occurring in women past the menopause. The streptococcus pyogenes is the most common

causative organism and is frequently found in association with the bacillus coli. The endometrium is replaced by granulation tissue, while there is usually an associated senile vaginitis, and sometimes pruritus vulvæ.

Symptoms. There is purulent foul-smelling discharge, irregular hæmorrhage, toxæmia, and occasionally cachexia.

Treatment. Curettage should be performed to ensure that the bleeding is not due to carcinoma. As the uterus is exceedingly soft and thin, the greatest care must be taken not to perforate it with the dilator or curette, as a subsequent spread of infection into the peritoneum or cellular tissues is liable to be fatal. After curettage a rubber tube should be inserted into the cavity and stitched to the cervix, and glycerine injected 3-4 times daily. The results of this treatment are as a rule very satisfactory.

Pyometra.

This is an accumulation of pus in a cavity of the uterus due to obstruction of the cervix and poor contractility of the musculature. It is most commonly due to carcinoma of the cervix, rarely to carcinoma of the body of the uterus, or it may follow a senile endometritis. A small quantity of pus may be present or the uterus may be greatly distended and the walls thinned.

Symptoms are the same as those of senile endometritis. On examination the uterus is found to be enlarged, and when a sound or dilator is passed foul viscid pus slowly escapes.

Treatment is the same as that for senile endometritis, except when there is great distension. When there is much pus or when there is recurrence after treatment total hysterectomy should be performed.

METROPATHIA HÆMORRHAGICA

This is a condition in which there are changes in the uterus and ovaries associated with prolonged and sometimes severe uterine hæmorrhage.

Uterine changes. The uterus is enlarged, firm in consistency, and the normal ante flexion is straightened out. The uterine wall may be increased in thickness up to an inch as the result of myo-hyperplasia, and of general hyperplasia of all the other elements such as fibrous

tissue and, in multiparæ, elastic tissue. The endometrium is greatly thickened and thrown into folds, with the formation of tongue-shaped projections which are often red or plum-coloured at the tip as the result of interstitial hæmorrhages. Numerous necrotic areas occur. Microscopically the thickening is seen to be due to hyperplasia, partly of the stroma cells, but mainly of the gland elements. As the result the glands are increased in length, tortuosity and calibre, especially in the middle layer, often forming cystic spaces filled with coagulated mucous and desquamated cells. The *necrotic areas* are void of a covering epithelium, the stroma and gland cells are seen to be undergoing disintegration, and there is a surrounding zone of intense hyperæmia. In many ways these changes resemble the disintegration of the endometrium associated with menstruation.

Ovarian changes are: (a) The presence in one of the ovaries of thin-walled unilocular cysts containing clear serous fluid and varying in size up to $2\frac{1}{2}$ inches in diameter. The number of cysts varies from one to three, seldom more. (b) General atrophy of the ovarian tissue around the cysts and in the opposite ovary. (c) Absence of a corpus luteum—perhaps the most significant feature. In young patients there may be no evidence of corpora albicantia, an indication that a corpus luteum has failed to develop.

Microscopically these cysts are lined with granulosa cells which occasionally, with those of the theca interna, show signs of atrophy and disintegration. In the majority of cases the follicles have not ruptured, but where this has taken place it is not followed by the development of lutein cells.

The disease is most commonly seen in parous women between the ages of 40 and 45, but it may affect patients of any age from adolescence until the time of the menopause.

Symptoms. The most characteristic feature is a prolonged spell of 6-8 weeks' continuous slight bleeding. This often follows a spell of 2-3 months' amenorrhœa, or may begin at the time of a regular period. Frequently the continuous bleeding is preceded by several months of severe menorrhagia, while in certain cases menstruation has previously been in every way normal.

Examination reveals a large firm uterus and an enlarged ovary. Usually there is no sign of pelvic inflammation, displacement, or fibroids, although the last mentioned may be present.

The cause of the condition is not definitely known. It seems reasonable to presume, however, that it is due to an excessive pro-

duction of œstrin in the absence of the inhibitory effect of progestin. Moreover, it is highly probable that there is some other hormone, excessive in amount or abnormal in character, which has a constant stimulating effect upon the ovarian follicles. This may be due to over-activity of the anterior part of the pituitary gland producing the follicle-ripening substance—prolan A. (rho. 1), or some other gland such as the suprarenal cortex may be elaborating an abnormal or excessive hormone. It is possible also that there is an absence or a diminished production of the luteinising hormone of the anterior pituitary—prolan B. (rho. 2).

Treatment. In many cases palliative treatment is unsatisfactory. In young patients every effort should be made to avoid removing the uterus. Measures as outlined under "Menorrhagia" should be adopted. Inhibitory substances such as luteinising hormone and insulin should be given a trial; the former is administered as antuitrin S. 100 r.u. daily for several weeks; the latter should be given in doses of 2-10 units daily together with $\frac{1}{2}$ -1 oz. of barley sugar three or four times daily. Curettage may be necessary, but whilst affording relief in certain cases, it does not effect a cure in more than 20 per cent. Watch should be kept on the patient's general health, and a hæmoglobin estimation frequently made; if this is persistently falling, more radical measures are indicated.

Utericuloplasty may be advised, but the patient should be warned that it may be unsuccessful. Hysterectomy should not be delayed until a serious state of anæmia has been established. Radium or X-rays will also cure the condition, but with the disadvantage of producing an early menopause from destruction of the ovaries.

Fibrosis Uteri (chronic metritis) must be classified with metropathia hæmorrhagica and functional menorrhagia. There is uterine enlargement associated with intractable menorrhagia and frequently prolonged and irregular bleeding.

In the past much attention has been given to certain histological changes in the uterine wall, which were held to account for the uncontrollable hæmorrhage. In some uteri there is a large proportion of fibrous tissue among the muscle bundles; in others an excess of elastic tissue in the intima of blood-vessels, surrounding arteries, and scattered throughout the musculature. It was thought that these fibrous and elastic elements replaced the muscle and interfered with its contractility, thereby removing one of the potent factors in the control of hæmorrhage. Other uteri showed no abnormality in the relative

amount of fibrous and elastic tissue, there being a general hypertrophy of all the elements. In the majority of these cases the endometrium is greatly thickened and polypoid, showing the same histological changes as have been noted in metropathia hæmorrhagica. In a small percentage atrophy of the endometrium is also noted, these cases probably falling into the same group as those described under functional menorrhagia.

The relative increase of elastic tissue is the normal condition following pregnancy and is roughly proportional to the number of children borne. Increase of fibrous tissue is probably due to previous endometrial or perimetrial inflammation, or to prolonged congestion. The general hypertrophy of the uterus is probably due to excessive or deranged hormonal activity, all the elements in the particular uterus affected taking part in the general hyperplasia.

NEW GROWTHS OF THE BODY OF THE UTERUS

These are :

- (A) *Innocent*. (1) Adenomatous polyp.
 (2) Fibro-adenomyomatous polyp.
 (3) Fibromyoma.
 (4) Endometrioma.
- B) *Malignant*. (1) Carcinoma.
 (2) Chorionic carcinoma.
 (3) Sarcoma.

(A) INNOCENT GROWTHS

(1) ADENOMATOUS POLYP OF THE ENDOMETRIUM

These are rounded or finger-like processes, rarely larger than a walnut. They may be single or multiple; the latter are usually seen in cases of metropathia hæmorrhagica. Sometimes they become greatly attenuated, and protrude from the cervix when attached to the endometrium by a long thin pedicle.

Microscopically they are seen to consist of endometrial stroma and glands together with blood-vessels and fibrous tissue. The glandular elements usually predominate, the tubules frequently being distended.

The covering epithelium may undergo metaplasia into the squamous type, especially when the polypus projects into the vagina.

Symptoms. The most characteristic symptom is metrorrhagia, and, on account of the associated endometrial thickening, menorrhagia and discharge. There may be spasmodic pain due to uterine contractions. The condition can be distinguished from fibromyoma, endometrioma, and carcinoma of the corpus uteri by means of curettage.

Treatment (see page 2472).

(2) FIBRO-ADENOMYOMATOUS POLYP

These are uncommon pedunculated growths formed of endometrial glands embedded in smooth muscle and fibrous tissue.

The symptoms, diagnosis and treatment are the same as those described under adenomatous polyp.

A *placental polypus* is not a growth, but a fragment of placenta remaining attached to the lining of the uterus and tending to increase in length by deposition of fibrin. It causes a blood-stained discharge which may be offensive, and there is usually an associated menorrhagia.

Treatment (see page 2472).

(3) FIBROMYOMA

This tumour, also called a *fibroid*, is the commonest growth found in the uterus with the exception of the simple mucous polypus. It is also one of the commonest of all neoplasms. It is a firm rounded spherical tumour, and may vary in size from a tiny seedling just visible to the naked eye to a tumour weighing anything up to 40 lb. At the present day, however, such tumours are usually removed before they attain great dimensions. They may occur singly or be multiple, sometimes exceeding 50 in number. They always arise in the muscular tissue of the uterus and are interstitial in the early stages. As they grow they are subjected to pressure by the uterine muscle and migrate in the direction of least resistance. According to their situation they may be (i) interstitial; (ii) subperitoneal; or (iii) submucous.

Interstitial fibroids remain in the muscular wall, which is displaced uniformly around them as they grow, thus causing a more or less regular expansion of the uterus and extension of its cavity (fig. 1183).

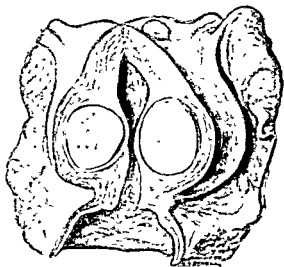


Fig. 1183.—INTERSTITIAL FIBROID.
(Mus., R.C.S.)

Subperitoneal fibroids bulge towards the surface of the uterus, coming to lie under the peritoneal coat. Here they may be sessile when attached by a broad base, or pedunculated when the attachment becomes attenuated. If springing from the fundus they tend to rise up into the abdomen, but occasionally, if arising from the sides or subperitoneal parts of the uterus, they may occupy various extra-peritoneal situations (fig. 1184).

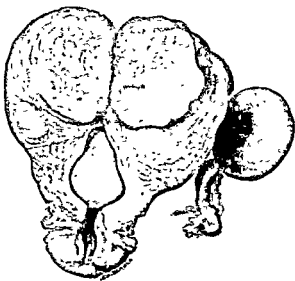


Fig. 1184.—FIBROIDS. ON THE RIGHT NEAR THE FALLOPIAN TUBE IS A PEDUNCULATED SUBSEROUS MYOMA. IN THE UPPER PART OF THE FUNDUS IS AN INTRA-MURAL GROWTH. TWO SMALLER ONES ARE SEEN IN THE WALL OF EACH SIDE. A PEDUNCULATED POLYPOID MYOMA LIES INSIDE THE UTERINE CAVITY.
(Mus., R.C.S.)

Submucous fibroids may be sessile or pedunculated, single or multiple. A pedunculated fibroid or fibroid polypus is one that has been extruded into the uterine cavity as the result of rupture of the capsule (figs. 1185 and 1186). It is covered with endometrium, and has an attachment to the inside of the uterus by a pedicle formed from the attenuated remains of the capsule. When attached near the fundus, the fibroid may cause uterine inversion of any degree on account of the pull on its pedicle (see fig. 1182).

Cervical fibroids constitute 5 per cent of all cases. They are always single. If near the mucous surface they may migrate towards the

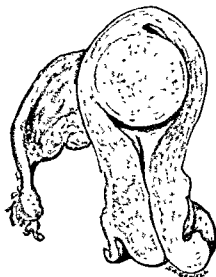


Fig. 1185.—SESSILE SUBMUCOUS FIBROID.
(Mus., R.C.S.)

cavity of the cervix and form a polypus ; if near the superficial surface they may become retroperitoneal, burrowing under the broad ligament or even behind the rectum. Fibroids growing in the cervix cannot easily rise into the abdomen, but remain in the pelvis, and after a time may completely fill this cavity and cause pressure on the pelvic organs. The uterus in such a case is lifted up and can often be felt on palpation to be perched on the summit or side of the tumour.

The *cause* is unknown. Fibroids are rarely seen before the age of 25, being most frequent between 40 and 50 ; they seem to be equally common in married and single women and appear to affect all races.

Pathology. These growths are believed to begin as a local overgrowth of the muscular and fibrous coats of a small artery. The vessel can be seen in the centre of a seedling fibroid.

Macroscopic and microscopic appearances. The tumour is enclosed in a capsule formed from uterine muscle from which it can be readily stripped; there is also an intervening layer of loose connective tissue supporting many thin-walled veins. The tumour on section has a distinctly white whorled appearance due to bundles of interlacing fibres. It cuts readily with a sharp knife except when it has undergone calcareous degeneration. The cut surface tends to become concave.

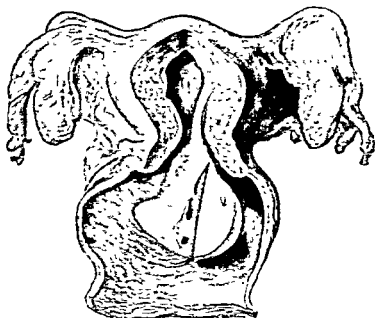


Fig. 1186.—PEDUNCULATED FIBROID.
(MMA, R.C.S.)

Microscopically the tumour consists of bundles of unstripped muscle running in all directions, and of white fibrous tissue, the relative proportions of which vary greatly. Soft tumours contain a predominance of muscle. Very few blood-vessels are seen, and these are mostly thin-walled capillaries and venules.

Associated changes in the uterus occur, depending on the size and situation of the fibroid which, when interstitial or subperitoneal, enlarges and distorts the cavity or displaces the uterus upwards, downwards, or to one side, or causes rotation. The endometrium is nearly always thickened, vascular, spongy with dilatation of the glands, and frequently thrown into folds and finger-like projections forming mucous polypi.

Immediately over the convexity of the tumour or on the wall opposite, the endometrium may be very thin and atrophic as the result of pressure. The Fallopian tubes are frequently the seat of a mild

chronic inflammation, and may be attached to the uterus and surrounding structures by many adhesions, or be distended by fluid forming a hydrosalpinx. The ovaries are said to be enlarged and cystic in about 25 per cent of cases.

Complications are : (1) Torsion ; (2) degeneration ; (3) infection ; (4) malignant change ; or (5) chronic inversion of the uterus.

(1) *Torsion* is comparatively rare, only occurring when there is a long pedicle. Twisting of the pedicle may result in complete occlusion of all the vessels and gangrene of the tumour. Partial strangulation, in which only the veins are obstructed, results in great engorgement of the fibroid, which becomes much swollen and discoloured. The tumour when not removed is liable to become infected from adherence to the bowel. When the torsion occurs slowly with partial obstruction of the veins, extensive adhesions are formed ; these become vascularised and a new blood supply is established which may permit the tumour to grow in a different situation should the original pedicle become obliterated.

On very rare occasions when the fibroid is large, rising into the abdomen and elongating the uterus, the latter may be twisted, torsion taking place at the cervix. Strangulation follows with rapid swelling, congestion, and hæmorrhage into the substance of the uterus and tumour, and blood may escape from the vagina.

(2) *Degenerative Changes.*

(a) *Simple atrophy* is said to occur at the menopause, but this is very doubtful. The apparent shrinkage of the tumour may be explained by the atrophy of the overlying uterine muscle.

(b) *Liquefaction, hyaline and myxomatous degeneration* are the commonest of all changes which may occur in fibroids, especially those of long standing or of large size. The degenerative process begins as a hyaline necrosis of the cell protoplasm which loses its staining characteristics and droplets of fluid form in the cells ; the nucleus breaks up and disappears. The fibrous tissue appears to be affected first. Coalescence of the drops of fluid results in the formation of cavities which further coalesce into larger spaces traversed by trabeculæ of unaltered tissue. Sometimes the whole tumour becomes converted into a cavity containing fluid, a condition formerly described as fibrocystic disease.

The fluid contains albumen but no mucin, is usually clear but is yellowish or brownish in colour. Clinically these cystic fibroids rapidly increase in size, become soft and fluctuating, and resemble ovarian cysts.

(c) *Necrobiosis or red degeneration* (fig. 1187). This is an *acute* condition usually associated with pregnancy or the puerperium. The cause is not definitely known, but is presumed to be due to a deficient blood supply or to infection with organisms such as bacillus Welchii or bacillus coli.

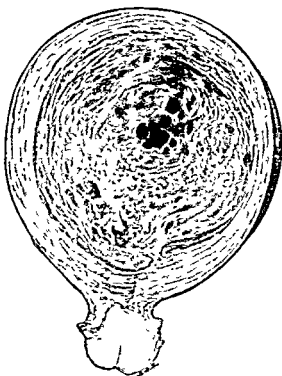


Fig. 1187.—RED DEGENERATION OR NECROBIOSIS. THE SPECIMEN SHOWS A UTERUS DIVIDED VERTICALLY, IN THE WALL OF WHICH IS A FIBROMYOMA UNDERGOING DEGENERATION. THE CUT SURFACE IS OF A DEEP PLUM COLOUR, AND THERE ARE MANY FOCI OF LIQUEFACTION. MICROSCOPICAL EXAMINATION SHOWED FINE PIGMENTED GRANULES WIDELY SCATTERED THROUGHOUT THE SUBSTANCE OF THE GROWTH. MANY OF THE TUMOUR CELLS WERE NECROTIC AND SOME OF THE BLOOD-VESSELS WERE THROMBOSED. THE TUMOUR WAS OF SUCH A SIZE AS TO FILL THE PELVIS, CAUSING INCREASING DIFFICULTY IN MICTURITION. THE PATIENT WAS NOT PREGNANT. THERE WAS UNDOUBTEDLY EXCESSIVE PRESSURE ON THE GROWTH AS THE RESULT OF ITS INCARCERATION IN THE PELVIS. THERE WAS NO HISTORY OF VIOLENT PAIN OR PYREXIA. (Mus, R.C.S.)

Pathology. The fibroid becomes soft and of a dull red colour resembling raw beef. Cystic spaces are formed by liquefaction of the protoplasm of the cells. Degeneration usually begins in the centre, spreading to the periphery, but sometimes the reverse occurs. Tumours of any size may be affected.

Microscopical appearances are in no way characteristic, but are identical with those described under "Liquefaction." According to Stevens the colour is due to a lipoid substance derived from hæmoglobin staining the cells and not to the

extravasation of blood, although the capsular veins may be extensively thrombosed.

Treatment. When red degeneration occurs during pregnancy, pain should be relieved with morphia. Expectant treatment may be given a trial, but, where unsuccessful, operation should not be unduly delayed. Myomectomy is the operation of choice, the uterine contents being left undisturbed.

When the condition occurs during the puerperium myomectomy should be performed immediately.

(d) *Calcareous degeneration* is due to deposition of calcium salts in the tumour. This may begin in the centre, spreading peripherally, or may occur in irregular patches. The condition is usually seen after the menopause or in very large tumours in younger women. It is often associated with fatty degeneration.

(e) *Fatty degeneration* is characterised by the deposition of fatty droplets in the muscle-fibres. On section the tumour shows yellowish softened areas.

(f) *Telangiectatic or lymphangiectatic degeneration* is a very rare occurrence in which there is great dilatation of the lymphatics and capillary vessels throughout the tumour.

(3) *Infections* may occur from the endometrium, from a chronic salpingo-oöphoritis, or from the bowel.

Infection from the endometrium is the commonest, affecting polypoid and submucous fibroids and usually occurring after labour or abortion, or with senile endometritis. Necrosis and sloughing of the tumour follows, causing a foul discharge and irregular bleeding. Occasionally after labour the growth may be extruded.

Infection secondary to salpingitis or from the bowel affects sub-peritoneal fibroids only, and is of comparatively rare occurrence. Organisms may invade the tumour when a loop of bowel, or less frequently an inflamed appendix, adheres to its surface. Extensive adhesions usually form to bowel, omentum and pelvic viscera. Suppuration and abscess formation may follow, but are unusual.

(4) *Malignant changes* are of two kinds: (i) malignant metaplasia, and (ii) malignant invasion.

Malignant metaplasia can only be of a mesoblastic type—sarcomatous. The estimated frequency varies from 0.5 to 2 per cent of diagnosed fibroids.

Pathology. Macroscopically the sarcoma appears as a firm homogeneous mass bearing a sharp contrast to the whorled white surface of the cut fibroid. Sometimes there are hæmorrhagic areas and large collections of blood clot. Microscopically the growth may be round-, spindle-, giant-celled, or more commonly a mixture of all three types.

Very little connective tissue stroma is to be seen, and the capillaries have thin walls which are deficient in places.

Malignant invasion results from carcinoma arising in the epithelium and glands of the endometrium and secondarily invading the fibroid (fig. 1188). Sarcoma may arise in the stroma of the endometrium and spread to the fibroid, but this is rare.

It is possible that a uterine tumour which is supposed to be a fibroid may from the first be a sarcoma of low malignancy.

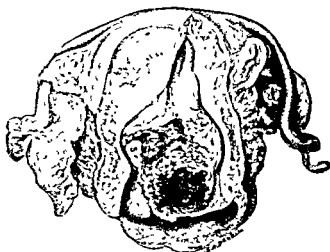


Fig. 1188.—MALIGNANT CHANGE IN A FIBROID. THE SECTION SHOWS A UTERUS WITH APPENDAGES AND A PORTION OF THE VAGINA. THE ANTERIOR PART OF THE BODY AND CERVIX HAVE BEEN REMOVED. THE PEDUNCULATED FIBROMYOMA ATTACHED TO THE POSTERIOR WALL OF THE UTERUS WAS DILATED THE CERVIX AND IS JUST PROJECTING AT THE EXTERNAL OS. THE SURFACE OF THE EXTRUDED PORTION IS BEING INVADDED BY CARCINOMA. (MMA, R.C.S.)

Relation of Fibroids to Conception. Fibroids and sterility are usually associated, and women who have been sterile for years often develop fibroids later in life. Submucous and especially polypoid growths are a deterrent to pregnancy, while interstitial tumours have little effect, and subserous no effect, upon conception.

Relation of Fibroids to Pregnancy and Labour. There is a tendency to abortion when pregnancy does occur in the presence of fibroids, especially when the tumour is submucous. In this case there is a possibility of the trophoblast eroding its way through the thin endometrium and opening up vessels in the capsule. Labour will be obstructed if the tumour is in the cervix or lower part of the uterine body so that it cannot be pushed above the pelvic brim. During pregnancy the tumours increase in size and may undergo necrobiosis

or red degeneration. During delivery the capsule may be ruptured and the tumour extruded.

Post-partum hæmorrhage is occasionally caused by a fibroid interfering with uterine contraction and retraction, or by rupture of the capsule during labour. During the puerperium the fibroid may suppurate from infection following injury and may slough away after weeks of illness, or the patient may die from septic absorption.

SYMPTOMS IN CASES OF FIBROIDS

Fibroids are not of themselves painful, and may develop to a considerable size without giving any intimation of their presence.

The symptoms in cases of fibroid will be found to vary according to the presence or absence of complications. For instance, there may be symptoms due to degeneration, to pressure effects during pregnancy or labour, to malignant change, or to miscellaneous causes.

Symptoms common in variable degree to all fibroids are hæmorrhage, pain, leucorrhœa and abdominal enlargement. Hæmorrhage usually occurs as menorrhagia, and occasionally as metrorrhagia when the capsule is ruptured or the tumour polypoid. The excessive loss is due to uterine congestion associated with the tumour, thickening of the endometrium, enlargement of the uterine cavity, and interference with uterine contraction. Subserous fibroids seldom have any influence on menstruation; interstitial and especially submucous tumours cause the most severe hæmorrhage.

Pain of an aching or "bearing down" character is felt in cases of large cervical fibroids or with those retroverting the uterus and subjecting the prolapsed ovaries to pressure.

Leucorrhœa as a continuous mucous discharge is occasionally present.

Abdominal enlargement is only noted when the tumour rises above the pelvic brim.

Symptoms due to degeneration. Red degeneration (necrobiosis) causes fever with a high temperature, which is more or less continuous with sharp rises in the evening, and the patient may be acutely ill with all the symptoms of toxæmia. The tumour is extremely tender, and there is abdominal rigidity.

Calcification usually causes pain from increased weight of the tumour. Rapid enlargement of the tumour occurs in cystic degeneration.

Symptoms due to relation of the fibroid to pregnancy and labour. During pregnancy the fibroid enlarges rapidly owing to the increased growth of the uterus. After labour a fibroid may cause hæmorrhage from interference with uterine retraction, or intermittent pain from uterine contractions during the process of expulsion. Should the growth become infected there will be marked fever, all the symptoms of toxæmia, and occasionally severe hæmorrhage due to sloughing of the growth.

Symptoms due to pressure on neighbouring organs. Pressure on nerves and veins only occurs on very rare occasions when the tumour is incarcerated in the pelvis. Retention of urine, sudden in onset and liable to recur, is the most important. It is usually due to elongation and stretching of the neck of the bladder associated with retro-uterine and cervical growths. Very large tumours may embarrass breathing.

Symptoms due to accidental occurrences. Infection and sloughing of the growth will give rise to fever, pain, foul discharge, and uterine bleeding which is sometimes severe.

Torsion of a subperitoneal pedunculated growth will cause sudden severe abdominal pain, marked tenderness of the lower abdomen without any rise of temperature, and very slight increase in pulse-rate. Torsion, however, is very rare, and strangulation is seldom complete.

Hæmorrhage into the peritoneal cavity from a ruptured vein on the surface of the tumour is very rare. It causes sudden severe abdominal pain together with all the symptoms and signs of intra-peritoneal hæmorrhage.

Symptoms due to malignant change. Sarcomatous change causes pain in the lower abdomen, rapid enlargement and softening of the tumour, menorrhagia and metrorrhagia.

Carcinoma associated with a fibroid causes irregular uterine bleeding. Enlargement of the tumour, cachexia and wasting are late symptoms.

Symptoms due to miscellaneous causes. Digestive disturbances occasionally occur. Anæmia results from uterine hæmorrhage. Anxiety neurosis may arise when the patient is aware of the presence of the tumour.

SIGNS

On palpation a typical fibroid is found, which is globular, very firm, non-elastic, mobile, and not tender. Submucous tumours produce symmetrical, and interstitial tumours asymmetrical enlargement of the uterus; frequently the rounded firm growth can be defined in the softer substance of the uterine muscle. Subperitoneal fibroids can often be felt to be attached to the uterus, but not incorporated with its substance. Fibroid polypi may be felt through the dilated cervix. When protruding they can be felt and seen. A submucous growth may also be palpated through the dilated cervix, or its contour may be defined with a uterine sound.

DIAGNOSIS

Differentiation must be made from :

(a) *Pregnancy*, when the fibroid is small, soft, and uniformly enlarging the uterus, and especially if there is retroversion. This type of growth is almost certain to be associated with menorrhagia, while in pregnancy there will be a history of amenorrhœa and other symptoms and signs of gestation, and Aschheim-Zondek or Friedman tests will be positive. If the patient is kept under observation for four to six weeks rapid enlargement and softening of the uterus will be noted.

(b) *Vesicular mole*. There will be amenorrhœa, very rapid growth of the uterus, positive urinary tests, later irregular hæmorrhage, and finally the passage of typical vesicles.

(c) *Fibroids plus pregnancy*. Here there will be amenorrhœa and other symptoms and signs of pregnancy with positive urinary tests.

(d) *An ovarian cyst* which may be confused with a fibroid undergoing cystic degeneration can usually be felt apart from the uterus, which when moved does not transmit the movement to the cervix. Menstruation is seldom affected. Difficulty will arise when the pelvic growth is firmly attached to the uterus, when the whole appears to form one indistinguishable mass. Fibroids which uniformly enlarge the uterus cause menorrhagia; ovarian growths never do.

(e) *Metropathia hæmorrhagica*. The uterus is uniformly enlarged, pyriform in shape, and regular in consistency. Endometrium removed with the curette shows necrotic areas.

(f) *Salpingo-oöphoritis*, when the enlarged tubes and ovaries are attached to the uterus. There is usually a history of acute illness and pelvic pain, and marked tenderness and fixity of the pelvic mass are revealed by examination.

PROGNOSIS

Fibroids may be present for years without producing any symptoms or untoward effects; there are, however, many important complications. Menorrhagia tends to produce ill-health, and is liable to render the patient susceptible to intercurrent diseases from lowered vitality.

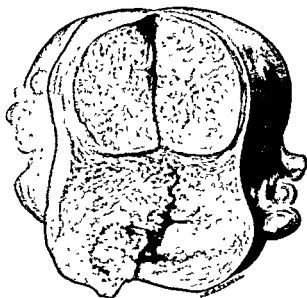


Fig. 1189.—A SMALL FIBROMYOMA OF THE UTERUS ASSOCIATED WITH CARCINOMA. (M^c, R.C.S.)

When it is prolonged a severe type of anæmia is sometimes produced which ends fatally even after removal of the tumour. Tumours complicating or obstructing labour may cause fatalities, as may also infection or sloughing of the growth. Sarcomatous change is rare, but the diagnosis is seldom made sufficiently early to permit of successful removal. Carcinoma arising in association with fibroids can usually be diagnosed at an early stage, but valuable time may be lost owing to the irregular hæmorrhage being attributed to the fibroid (fig. 1189). Urinary obstruction is also comparatively rare, but it may kill the patient by producing pyelonephritis. Fibroids are typical examples of non-malignant growths and are usually regarded as harmless; yet they all bear within them the potentialities of fatal complications.

TREATMENT

Fibroids when small and not causing symptoms require no immediate treatment, but the patient should always be kept under observation for early evidence of complications. Treatment is palliative, radiological or operative.

Palliative treatment consists in the relief of menorrhagia pending operation.

Radiological treatment is indicated in certain cases.

Operative treatment is always indicated when a fibroid is large, rising above the pelvic brim or filling the pelvis, when growing in the cervix or lower uterine segment, when polypoid or pedunculated, either submucous or subperitoneal, when causing pelvic pain, menorrhagia or metrorrhagia, when associated with sterility or abortion, when inflamed or twisted, when increasing in size and perceptibly becoming soft, or when undergoing any degeneration.

One of the following operations may be indicated :

- (1) Curettage (see page 2465).
- (2) Myomectomy—vaginal (see page 2474) or abdominal (see page 2515).
- (3) Hysterectomy—total or sub-total (see page 2477).

(4) ENDOMETRIOMA

This is a diffuse non-encapsuled growth affecting a localised part of the uterine wall, usually the posterior, or occasionally replacing the greater part of the muscular tissue. Microscopically it is composed of unstriped muscle arranged in irregular bundles and endometrial stroma cells and glands lined with cubical epithelium. On naked-eye section the surface has a white fibrillary appearance. Scattered through its substance are cystic spaces of variable size. Some part of the growth is always in contact with the endometrium, in which downgrowths of stroma and glands may be seen. The cause of the development of such a tumour is not known, but there seems to be little doubt that it has its origin in the uterine endometrium which invades the musculature which, in the neighbourhood of the invading glands and stroma, takes on proliferative activity (fig. 1190).

The *symptoms* are menorrhagia—often profuse and uncontrollable, pelvic pain and leucorrhœa. The uterus on examination will be found to be enlarged and soft. The growth although non-encapsuled and locally invasive never forms secondaries, and when completely removed does not recur. During pregnancy the endometrial stroma cells undergo decidual reaction.

Treatment is total hysterectomy (page 2481).



(B) MALIGNANT GROWTHS

(1) CARCINOMA OF THE BODY OF THE UTERUS

This usually occurs between the ages of 50 and 60, being extremely rare before the age of 40 or after the age of 70. Its incidence has no relation to child-bearing, being equally common in parous and non-parous uteri. Microscopically the growth is a columnar-celled adeno-carcinoma arising in the endometrial glands, and consists of irregular and branching alveoli which may be lined with a single or many layers of columnar epithelium, or even be filled with masses of the cells. Occasionally the epithelium appears to undergo metaplasia into the squamous-celled type of growth, in which there are cell-nests with keratinoid centres; their invasive qualities are obvious, groups of cells and alveoli being seen among the muscle bundles of the uterine wall (fig. 1191). The growth may penetrate the musculature and the peritoneal coat, malignant cells then becoming scattered over the peritoneum (figs. 1192 and 1193). This, however, is rare until the condition is far advanced.

The growth may be either *localised* or *diffused*. The former variety springs from a

small area of the endometrium, and a large fungating mass is formed which may eventually fill the cavity and cause enlargement and softening of the uterus. The latter type infiltrates the endometrium very extensively, tending to necrose and break down, and making the walls of the cavity ragged, friable and ulcerated. The

Fig 1191.—ENDOMETRIO-MA OF THE UTERUS. THE SPECIMEN IS A SAGITTAL SECTION OF A UTERUS ON THE POSTERIOR WALL OF WHICH ARISES A LOBULATED TUMOUR. THE SURFACE IS NOT PAPILLARY AND THE UTERINE MUSCLE IS NOT INVADIED. HISTOLOGICALLY, THE GROWTH CONSISTS OF STIMEROUS SPACES LINED WITH COLUMNAR EPITHELIUM SIMILAR TO THE GLANDULAR ELEMENTS OF THE ENDOMETRIUM. THE BASE OF THE GROWTH IS IDENTICAL HISTOLOGICALLY WITH A FIBROMYOMA. THIS IS REALLY A LOCALISED ADENOMYOMA OR ENDOMETRIO-MA OCCURRING FROM THE INNER SURFACE OF THE UTERINE WALL AND NOT INVADING ITS SUBSTANCE.
(Mac., R.C.S.)

mode of spread is by direct infiltration of the uterine muscle and by permeation of the lymphatics which run in the upper part of the broad and ovario-pelvic ligaments to the iliac and lumbar glands, and to a lesser degree along the lymphatics of the round ligament invading the glands in the groin. In late cases the tubes and cervix may also be invaded. Pyometra may result from infection of the growth and blocking of the internal os.

Symptoms occur fairly early, and as they usually arise after the menopause they should never fail to arouse suspicion. In the early

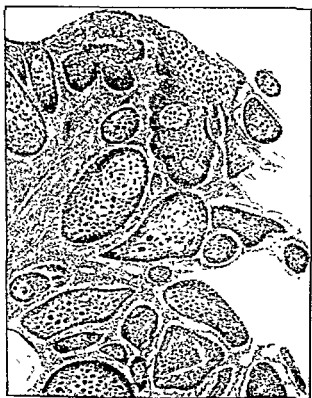


Fig. 1191.—CARCINOMA OF THE ENDOMETRIUM IN AN ADVANCED STAGE. THIS GROWTH HAS ALL THE APPEARANCES OF A SQUAMOUS-CELLED CARCINOMA. THERE ARE IRREGULAR MASSES OF CELLS, THE CENTRAL PORTION OF WHICH IN PLACES SHOW KERATINOID CHANGES.

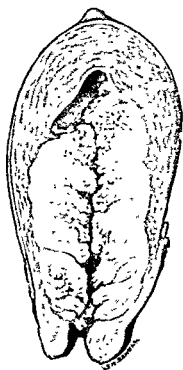


Fig. 1192.—CARCINOMA OF THE BODY OF THE UTERUS. THE SPECIMEN SHOWS A SAGITTAL SECTION OF THE UTERUS. THE UPPER PART OF THE CERVICAL CANAL AND ALMOST THE ENTIRE INNER SURFACE OF THE BODY, EXCEPT AT THE FUNDUS, ARE INVOLVED BY CANCER. ON NAKED-EYE INSPECTION, THE NEOPLASM APPEARS TO BE FAIRLY WELL DEMARCATED FROM THE UTERINE MUSCLE. HISTOLOGICAL EXAMINATION SHOWS THE NEOPLASM TO CONSIST OF MASSES OF SPHEROIDAL CELLS, PROCESSES OF WHICH INVADE THE UTERINE MUSCLE ALMOST TO THE PERITONEAL SURFACE. THIS IS A DIFFUSE SPHEROIDAL-CELLED CARCINOMA OF THE ENDOMETRIUM. (Muz., R.C.S.)

stages there is a watery blood-stained discharge followed by irregular but seldom severe bleeding. Hæmorrhage often occurs after exertion, coitus or examination. The discharge later becomes purulent and offensive. Pain is much more often an early symptom than in cancer of the cervix, but is not by any means always present. Bimanual examination is often negative. In the fungating type of growth the uterus is larger and softer than normal. In the diffuse type the uterus is normal in size or only slightly enlarged, and is very firm. Sometimes the os is dilated and the fungating growth can be palpated through the canal.

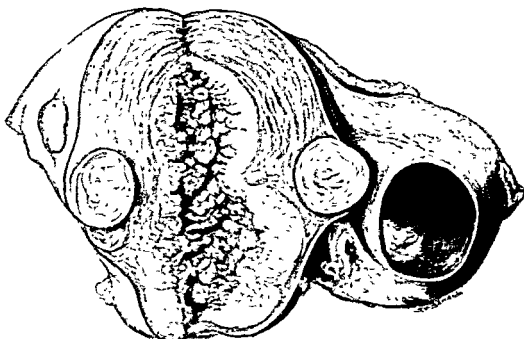


Fig. 1153.—CARCINOMA OF THE BODY OF THE UTERUS. THE WHOLE ENDOMETRIUM IS DIFFUSELY INVADIED BY A COLUMNAR-CELLED CARCINOMA. THE LEFT TUBE IS DISTENDED WITH FLUID—HYDROSALPINX.

(Mrs. R.C.S.)

A *diagnosis* must be made from endometrial polypus, senile endometritis and sloughing submucous fibroid, and can only be confirmed by exploratory curettage.

Treatment is total hysterectomy, abdominal or vaginal. The prognosis after hysterectomy is very good. The operative mortality is probably less than 5 per cent, and the curability-rate over 50 per cent.

(2) CHORIONIC CARCINOMA

This is a rare growth arising in the foetal trophoblast. The primary growth is usually in the uterus, but on very rare occasions may be in

the tube following tubal gestation, or in the vagina. It is interesting to note that chorionic carcinoma may arise in ovarian, testicular or intra-thoracic teratomata. Three elements are seen on microscopical section: (i) Masses of discrete mononucleated cells with clear protoplasm and a well-defined nucleus. These are identical with Langhans' cells of the chorionic villi. (ii) Plasmodium or masses of protoplasm of varying sizes and containing many nuclei. These are identical with the syncytial layer of the villi. (iii) Large isolated cells with a single nucleus and containing numerous granules. The relative proportion of these elements may vary widely.

The growth rapidly invades and destroys the uterine muscle and also disseminates widely via the blood stream (fig. 1194).

Secondary growths in the vagina are extremely common. Chorionic carcinoma is regarded as one of the most malignant neoplasms, death having been known to occur within one month of the onset of symptoms, although there are wide variations of malignancy. Cures have followed simple curettage, and secondaries have disappeared spontaneously after hysterectomy. The occurrence is interesting and important; over 50 per cent of recorded cases have followed hydatidiform mole, a few have occurred after abortion, and still fewer have followed labour.

Symptoms. Uterine hæmorrhage, which may be irregular or persistent from the onset. Persistent lochia following the expulsion of a hydatidiform mole or irregular bleeding occurring some weeks or months afterwards should always arouse suspicion. There is often a rise of temperature, and pallor and wasting are usually marked from the beginning. The uterus is enlarged and soft and bleeds readily on examination. Plum-coloured nodules in the vagina due to secondary deposition are very characteristic. These when examined microscopically show the typical appearances of the growth. When its

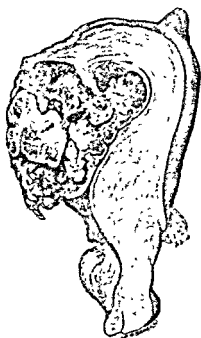


Fig. 1194.—CHORIONIC CARCINOMA. THE UTERUS IS CUT VERTICALLY SHOWING A MASS OF NEW GROWTH HANGING LOOSE IN THE UTERINE CAVITY. THE FUNDUS IS PERFORATED BY THE NEOPLASM. NUMEROUS HÆMORRHAGES HAVE TAKEN PLACE INTO THE SUBSTANCE OF THE GROWTH, AND THESE ARE MORE MARKED NEAR THE MARGIN OF INVASION OF THE UTERINE MUSCLE WHICH IS VERY CHARACTERISTIC OF CHORIONIC CARCINOMA. (Moss, B.C.S.)

presence is suspected the Aschheim-Zondek or Friedman test should be made. It is better to avoid performing curettage for fear of causing dissemination via the blood stream.

Treatment is total hysterectomy, which should be performed even when secondaries are known to be present. This should always be followed by deep X-ray therapy as the growth is extremely vulnerable to radiation. Two weeks after hysterectomy the Aschheim-Zondek or Friedman test should be made to determine whether or not actively-growing chorionic tissues (secondaries) are present anywhere in the body; if these are detected they should be subjected to deep X-ray treatment.

(3) SARCOMA

This is very rare. It may arise as a circumscribed tumour in the uterine muscle—interstitial type—or in the endometrium, arising from

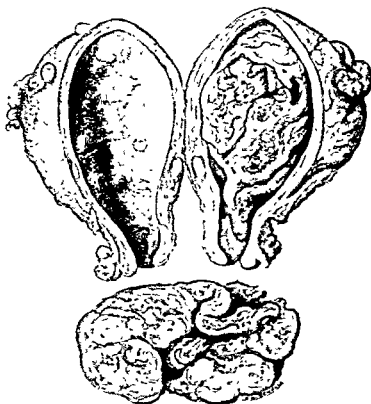


Fig. 1193.—SARCOMA OF THE UTERUS. THE SPECIMEN IS AN ENLARGED UTERUS DIVIDED SAGITTALLY. ONE SIDE IS FILLED WITH A LARGE MASS OF GROWTH WHICH EXPANDS THE UTERUS AND THE CERVIX. THE OPPOSITE SIDE SHOWS NO INDICATION OF INVASION. BELOW THE UTERUS IS A HUGE MASS OF GROWTH WHICH HAD BEEN PASSED SPONTANEOUSLY A FEW DAYS BEFORE OPERATION. MICROSCOPICAL EXAMINATION OF THE MASS EXPELLED AND OF THAT IN THE UTERUS PROVED THEM TO BE A MIXED-CELL SARCOMA IN WHICH THERE WERE NUMEROUS LARGE STRIATED MUSCLE CELLS IN ALL STAGES OF DEVELOPMENT. (Mss., R.C.S.)

the stroma cells (fig. 1195). In this latter situation it may be localised, forming a pedunculated mass in the cavity, or may permeate the lining of the uterus diffusely. Sometimes it arises in a fibroid. In either situation the growth may be round-, spindle-, or giant-celled, or a mixture of all these varieties (figs. 1196 and 1197). It is highly malignant, invading and penetrating the uterine wall and spreading via the blood stream.

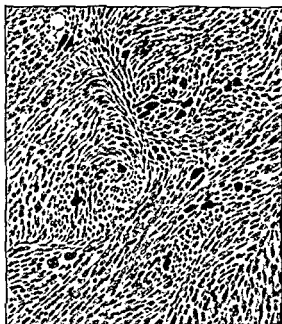


Fig. 1193.—SARCOMA OF THE UTERUS. SPINDLE- AND MIXED CELLED TYPE OF GROWTH.

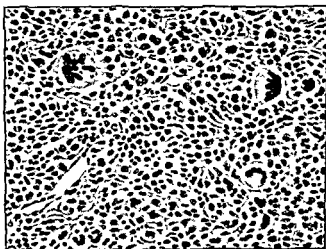


Fig. 1197.—SARCOMA OF THE UTERUS. ROUND- AND GIANT CELLED TYPE OF GROWTH.

The *symptoms* are irregular uterine hæmorrhage, rapid enlargement and softening of the uterus, and occasionally pain.

A *diagnosis* can only be made by removing a portion of the growth with a curette.

The *treatment* advised is total hysterectomy followed by deep X-ray therapy.

CHAPTER VII

FALLOPIAN TUBES AND PELVIC CELLULAR TISSUES

THE Fallopian tubes are the Müllerian ducts which have persisted in a relatively primitive state.

The following affections will be described :

- (1) Developmental abnormalities.
- (2) Inflammations.
- (3) Tubal pregnancy.
- (4) New growths.

DEVELOPMENTAL ABNORMALITIES

Absence of one or both tubes is unknown, but a rudimentary tube, occasionally without a lumen, is associated with the undeveloped horn of a unicornuate uterus.

Accessory or para-tubes which have fimbriated extremities but no ostia are sometimes found attached to the ampulla of one of the normally developed tubes. Small sacculations of the tube or diverticula are also said to occur, and in them a fertilised ovum may become embedded.

INFLAMMATIONS

- (a) Acute : (i) catarrhal ; (ii) suppurative.
- (b) Chronic : (i) non-suppurative ; (ii) suppurative ; (iii) tuberculous.

Acute salpingitis is almost invariably bilateral. The cause is always bacterial infection which is secondary to gonorrhœa, puerperal or post-abortion sepsis, or infection spreading from the alimentary canal or through the blood stream.

Gonorrhœa is the cause of about 75 per cent of all cases, gonococci spreading upwards from the cervix via the endometrium by direct

continuity of surface. Tubal inflammation seldom occurs sooner than two weeks after the original infection and may be delayed for several years.

Puerperal or post-abortion sepsis. Infection usually takes place during the second or third week after labour or abortion, and follows acute septic endometritis. As the uterine ostium of the tube is closed for several days after labour, it is probable that the infection spreads via the uterine and peri-tubal lymphatics. The streptococcus pyogenes is the usual organism found, though occasionally it is the gonococcus, rarely the bacillus coli, and sometimes a mixture of all three organisms.

Infection from the alimentary canal. A streptococcal pelvic peritonitis due to an inflamed appendix hanging over the brim of the pelvis is the commonest cause of inflammation from the alimentary canal. Infection may occasionally spread from a diverticulitis of the pelvic colon.

Infection through the blood stream. Acute salpingitis may on rare occasions be associated with one of the acute specific fevers.

Tuberculous salpingitis is believed to be the result of a blood-borne infection.

PATHOLOGY

Catarrhal salpingitis is a non-suppurative inflammation of the tubal mucosa which pours out a clear serous fluid. After repeated attacks the abdominal ostium becomes sealed and fluid accumulates in the tube, resulting in a hydrosalpinx (fig. 1198).

Acute suppurative salpingitis. The mucous membrane of the tube is markedly infiltrated with polymorphonuclear leucocytes and serum. The plicæ are greatly swollen, and the ciliated epithelium is desquamated in patches. Serum, and later pus, is exuded into the lumen and escapes into the peritoneal cavity causing peritonitis and oöphoritis. The muscular walls of the tubes and later also the cellular tissues of the broad and ovario-pelvic ligaments become infiltrated with leucocytes and serum. The tube is greatly swollen, congested, and plum-coloured, the peritoneal coat is covered with plastic lymph, and adhesions form to neighbouring structures such as bowel, uterus, broad ligament, ovary, and the peritoneum of the pouch of Douglas. The fimbriae become oedematous and curl in towards the lumen of the tube,

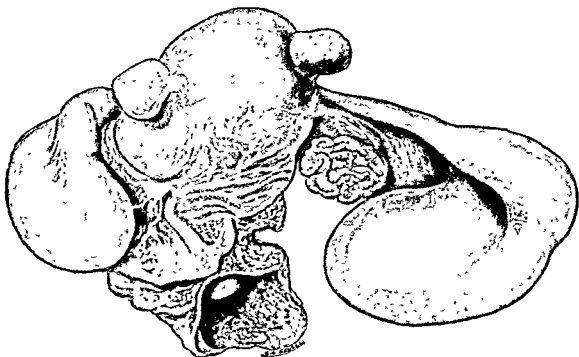


Fig. 1198.—HYDROSALPINX. THE RIGHT TUBE IS DISTENDED WITH FLUID, THE FIMBRIATED END HAVING BECOME INTOLDED AND OCCLUDED. THE PROXIMAL OR ISTHMIC PORTION OF THE TUBE SHOWS LITTLE DISTENSION. THE OVARY IS SHRUNKEN AND WRINKLED, BUT IS NOT ADHERENT TO THE TUBE. THE LEFT TUBE IS CONVOLUTED, DISTENDED WITH FLUID, AND ADHERENT TO THE OVARY WHICH IS ALSO CYSTIC—TUBO-OVARIAN CYST. (Mus., R.C.S.)

becoming adherent and closing the ostium. The tube then becomes distended with pus—*pyosalpinx* (fig. 1199). Organisms escaping in pus or serum from the ostium, or passing directly through the tube wall, infect the ovary, possibly through the opening of a recently ruptured follicle, and sometimes produce an *ovarian abscess*. The end of the tube frequently adheres to the ovary and the two structures become converted into a pus cavity—*tubo-ovarian abscess*.

Pelvic peritonitis is common, plastic lymph being poured out and extensive adhesions being formed between bowel, omentum and the pelvic viscera, often with the development of a localised pelvic abscess.

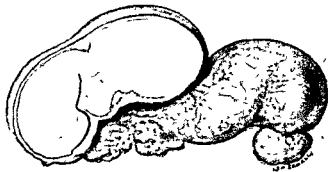


Fig. 1199.—PYOSALPINX. (Mus., R.C.S.)

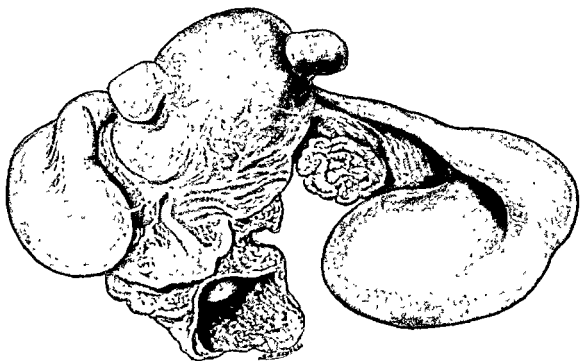


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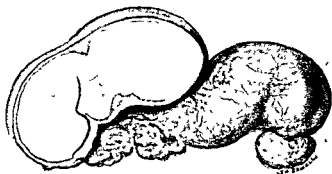


Fig. 1199.—PYOSALPINX. (Mus., R.C.S.)

continuity of surface. Tubal inflammation seldom occurs sooner than two weeks after the original infection and may be delayed for several years.

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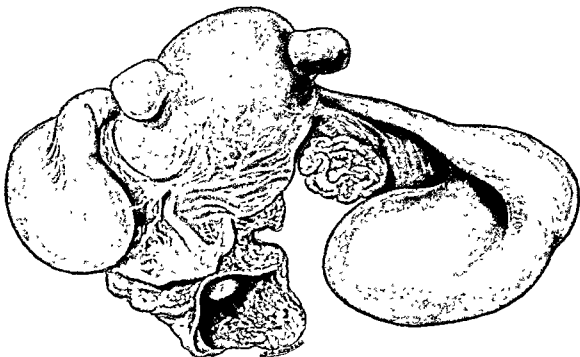


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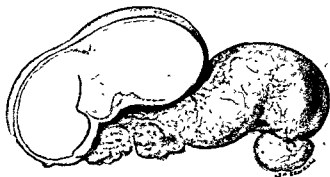


Fig. 1199.—PYOSALPINX. (Mus., R.C.S.)

The veins of the mesosalpinx, and occasionally of the ovario-pelvic ligaments, may become inflamed and thrombosed at a later stage. In cases of puerperal salpingitis the thrombosis sometimes spreads above the pelvic brim.

RESULTS

(1) *Resolution* is common but is never quite complete; numerous peritoneal adhesions usually remain, binding the tube to the ovary and to other viscera. Intra-tubal adhesions occur as the result of adherence of the raw surfaces of desquamated areas, and the plicæ become bound together.

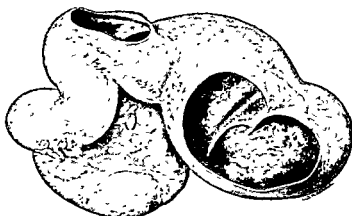


Fig. 1200.—TUBO-OVARIAN CYST. THE ABDOMINAL OSTIUM IS CLOSED, THE TUBE IS ADHERENT TO THE OVARY, AND BOTH STRUCTURES HAVE BEEN CONVERTED INTO A CYSTIC CAVITY. THE OPENINGS MADE IN THE TUBE SHOW THE WALLS TO BE UNIFORMLY THINNED OUT. THE MUCOUS MEMBRANE IS THROWN INTO DEEP FOLDS. A BRISTLE MARKS THE UTERINE END OF THE TUBE WHICH IS NOT DISTENDED. (Mue., R.C.S.)

(2) *Hydrosalpinx and tubo-ovarian cyst* (fig. 1200). Hydrosalpinx is a condition in which the Fallopian tube is distended with fluid following closure of the ostium abdominale (see fig. 1198).

Tubo-ovarian cyst is a condition in which the fimbriated end adheres to the ovary and in which both structures become distended with fluid.

(3) *Pyosalpinx.*

(4) *Tubo-ovarian abscess.*

(5) *Chronic salpingo-oöphoritis.* This results from repeated mild attacks of acute salpingitis. The tubal mucous membrane and wall become thickened and sclerosed as the result of fibrous organisation of

inflammatory exudates. The ovary is chronically inflamed, sclerosed, and frequently cystic due to failure of follicles to rupture ; it is usually adherent to the broad ligament, bowel or omentum.

SYMPTOMS

(1) *Of acute catarrhal salpingitis.* Pain of a moderate degree, sudden in onset and situated in the hypogastrium, is always present. It usually occurs just after a menstrual period, which is prolonged in time and the flow increased in amount. Fever is usually mild, the temperature not rising above 100° F., and the pulse-rate is not perceptibly increased.

(2) *Of acute suppurative salpingitis.* The symptoms are those of acute pelvic peritonitis, namely, pain, fever, uterine hæmorrhage and nausea.

- (a) *Pain* is severe in character, sudden in onset, and is felt in the hypogastrium, radiating upwards towards the chest.
- (b) *Fever* is marked, the temperature rising to 102° or 103° F. at the onset, becoming intermittent with evening rise and morning remission. The pulse-rate is quickened to 90 or 100, the tongue is dry and furred, the breath usually offensive, and the urine is dark in colour, occasionally containing traces of albumen. The fever tends to subside quickly with rest and treatment.
- (c) *Uterine hæmorrhage* is fairly common. Bleeding is marked and prolonged, whether the attack begins during or between the menstrual periods.
- (d) *Nausea* is usually felt at the onset of the attack, but vomiting seldom occurs unless the inflammation spreads from the pelvis to the general abdominal cavity.

(3) *Of chronic salpingitis.*

- (a) *Non-suppurative.* Advanced changes in the tubes and ovaries may occur with mild symptoms or even absence of symptoms. Usually, however, there is *pain* referred to the sacrum or pelvis, increasing on exertion and tending to decrease with rest ; premenstrual pain starting a week or several days before the period, constant and aching

in character and relieved when the flow is well established ; *menorrhagia* varying in degree ; *leucorrhœa* due to concurrent cervicitis ; *dyspareunia* due to tenderness as the result of pressure on the cervix and vaginal vault ; and *lassitude* and *depression*.

- (b) *Suppurative*. Here the symptoms are the same as in the non-suppurative variety, but are more pronounced and severe, with marked tendency to acute exacerbations, especially at the menstrual periods and after exertion. *Menorrhagia* is constant, and there is sometimes epimenorrhœa. The general health is always affected as the result of chronic toxæmia, and there is loss of weight, and a feeling of lassitude, persistent fatigue, mental depression, melancholia, flatulence and constipation. The clinical characteristics of the condition are acute exacerbations of symptoms, marked by hypogastric pain of varying severity, pyrexia, and frequently uterine bleeding.

PHYSICAL SIGNS

(1) *Acute catarrhal salpingitis*. Tenderness on pressure is always present in the hypogastrium, above Poupart's ligaments, in the lateral and posterior vaginal fornices, and upon manipulation of the uterus.

(2) *Acute suppurative salpingitis*. There are restricted movements of the abdomen. *Muscular rigidity* is produced by pressure but is seldom tonic. There is *tenderness* in the hypogastrium and iliac fossæ. On vaginal examination considerable discharge may be seen, pus can often be expressed from the urethra, and there may be tenderness of one or both of Bartholin's glands. The cervix is sometimes soft, directed forwards, and is very tender on movement. The uterus may be retroverted and fixed, extremely tender on manipulation, and there is always pronounced tenderness on pressure in the lateral and posterior fornices.

(3) *Chronic salpingo-oöphoritis and pyosalpinx*. The patient looks ill, and is pale and sallow. The abdomen is slightly tympanitic, tender on pressure above the pelvic brim, and becomes rigid on examination. On occasions after puerperal sepsis a pyosalpinx can be felt above the pelvic brim. On vaginal examination signs of gonorrhœa are frequently present, such as cervical discharge, pus from the urethra on compression, tenderness, and occasional induration of one or both of

Bartholin's glands. The cervix is often enlarged, firm in consistency, directed forwards, and sometimes displaced to one or other side. The uterus is difficult to define owing to marked tenderness on pressure. Usually it is retroverted or retroposed and fixed. There is great tenderness to pressure in the fornices, and occasionally ill-defined swellings and thickenings can be felt attached to the uterus and pelvic wall.

DIFFERENTIAL DIAGNOSIS

(1) *Acute catarrhal salpingitis* must be distinguished from a mild attack of appendicitis and from pyelitis.

(a) *Appendicitis*. In the early stages pain is felt in the region of the umbilicus or all over the abdomen, later becoming localised to the right iliac fossa. Nausea and vomiting are usually present, and there is tenderness at a point midway between the umbilicus and the anterior superior iliac spine.

(b) *Pyelitis*. Pain is felt in the loin on one or other side, and tenderness is most pronounced in the costo-vertebral angle; there are symptoms of cystitis, pus is present in the urine, and organisms may be cultivated from the urine.

(2) *Acute suppurative salpingitis* must be differentiated from appendicitis and ectopic gestation.

(a) *Appendicitis* (see above).

(b) *Ectopic gestation*. The onset of symptoms in this condition is very precipitate, shock is pronounced, and when bleeding has been severe there will also be symptoms and signs of internal hæmorrhage. The temperature is always sub-normal in the early stages. A cast may be passed from the uterus and in the majority of cases there is a history of amenorrhœa for one or two periods.

(3) *Chronic salpingo-oöphoritis (pyosalpinx)* is sometimes confused with ectopic gestation, but may be mistaken for almost any pelvic swelling. The condition must be distinguished from the following:

(a) *Tubal abortion with hæmatocele*. There is usually a history of amenorrhœa, the temperature is not elevated in the early stages, and a decidual cast may be passed from the

uterus. When a pelvic hæmatocele is formed, the cervix is forced forwards and upwards and may cause retention of urine.

- (b) *Torsion of an ovarian cyst.* Pain is sudden in onset and very severe; the temperature is usually normal or sub-normal, the pulse-rate slightly increased, and there is absence of discharge or uterine bleeding.
- (c) *Appendicular abscess*, when pelvic in position, can seldom be differentiated clinically from pyosalpinx. There is, however, absence of uterine bleeding and usually no vaginal discharge.
- (d) *A pelvic fibroid.* Tenderness is absent except on rare occasions when there is red degeneration, which condition is almost invariably associated with pregnancy and the puerperium.

TREATMENT

(1) *Of acute catarrhal salpingitis.* Absolute rest in bed in the Fowler position, interdiction of alcohol, restriction of diet, copious fluids and mild saline aperients are advised. Pain is relieved by radiant heat or fomentations to the abdomen, hot douching and pelvic diathermy. Infection of the urethra and cervix is at the same time treated by diathermy, ionisation or antiseptic applications.

(2) *Of acute suppurative salpingitis.* Opinions are sharply divided with regard to the relative merits of conservative or operative treatment.

Conservative treatment is conducted on the lines advocated for catarrhal salpingitis.

Operative treatment. In my opinion operation should in most instances be advised for the following reasons:

- (i) The suppurative process in the tubes and peritoneum is directly dealt with and the time of convalescence is reduced.
- (ii) The tubes can sometimes be preserved.
- (iii) Pyosalpinx and abscess formation or chronic sclerosis of the ovaries can usually be prevented.

- (iv) Chronic "pelvic invalidism" due to permanently thickened tubes is avoided.
- (v) Mistakes in diagnosis are obviated, as the condition may be confused with appendicitis or ectopic gestation.

Operative treatment consists of : *salpingostomy* (see page 2550) when the case is seen early before there is necrosis or induration of the tube ; or *salpingectomy* (see page 2546) when the tube is greatly swollen, indurated, or contains pus ; either operation being followed by *ventro-fixation of the uterus and pelvic drainage* (see page 2379).

(3) *Of chronic salpingo-oöphoritis and pyosalpinx.* Treatment may be medical or surgical. Medical treatment, on the lines advised for acute catarrhal salpingitis, is indicated when symptoms are mild, when the general health is not affected, when there are no acute exacerbations, when the uterus is mobile, tenderness is not pronounced, and thickening in the fornices is absent.

One of the following operations may be indicated for this condition : salpingectomy, salpingostomy, or salpingo-oöphorectomy, any of these being combined with ventro-fixation of the uterus ; or hysterectomy.

TUBERCULOUS SALPINGITIS

Tuberculous infection is comparatively common, accounting for about 10 per cent of all cases of chronic salpingitis. Post-mortem examination reveals affection of the tubes in 20 per cent of women who die from tuberculosis. Other organs are also affected in about 95 per cent of cases. It may occur at any age from childhood upwards.

The infection may be *blood-borne*, the primary lesion being in the lung, or result from tuberculous peritonitis by direct extension. In almost all cases of infection of the peritoneum, the tubes also are involved. Concurrent infection of the endometrium and tubes is common, the uterine lesion probably being secondary to the tubal.

Pathology. At an early stage of the disease miliary tubercles are seen in the submucosa ; these enlarge, coalesce, caseate, and finally break through the mucosa which is gradually destroyed, and the tube at the abdominal ostium, becoming sealed, is gradually distended with caseous material. The fimbriæ are seldom turned inwards as in gonococcal salpingitis. The tube varies in size, and is often much enlarged. The tube wall becomes thickened from fibrosis

and the peritoneal surface covered with miliary tubercles. Sometimes the wall is thin, and dense adhesions form to the pelvic walls and viscera. The ovary is frequently secondarily affected, with abscess formation.

On *microscopical* examination typical tuberculous giant-cell systems are seen in the tube wall and ovary.

Symptoms. These are indistinguishable from salpingo-oöphoritis. Menorrhagia is not always present, but when it occurs it is liable to be very severe and uncontrollable.

Diagnosis. The condition should be suspected when swellings can be felt in the posterior lateral fornices in adolescents and young virgins, if there is a history of tuberculous affection of the bowels or glands, or when there is gradual deterioration of health, loss of weight, persistent fever, and pelvic pain unrelieved by rest in bed.

Treatment. The tubes should always be removed by abdominal operation. Efforts must be made to conserve the ovaries or a part of one ovary, but in any case such a patient will be sterile. Hysterectomy is always indicated if the uterus is enlarged, congested, or if there has been menorrhagia, as it is highly probable that the endometrium is also affected. When dividing adhesions there is great risk of tearing the bowel, with resulting fistula formation. Serious or progressive tuberculosis of the lung is a contra-indication to operation.

TUBAL PREGNANCY

Extra-uterine or ectopic gestation is the arrest and development of a fertilised ovum at any point between the Graafian follicle and the endometrium.

The occurrence of primary abdominal pregnancy does not appear ever to have been proved. Ovarian implantation, although extremely rare, has been known to occur. Tubal pregnancy is the usual variety of ectopic gestation. The ovum may be implanted in the ampulla, the isthmus, or in the interstitial part of the tube; the first is the commonest, the last being very rare (figs. 1201, 1202 and 1203). Tubal and intra-uterine gestation have been known to occur together, and on rare occasions bilateral tubal implantation. The *cause* of arrest is unknown. Interference with its progress has been attributed to

kinking or spasm of the tube, the presence of polypi, congenital diverticula formed by inflammation, or the fact that the ovum is too large to pass along the lumen of the tube.

When the ovum comes to rest in any part of the tube it immediately burrows through the mucous membrane and comes to lie in the sub-mucosa; erosion continues into the musculature of the tube and blood-vessels, there being no compensatory decidual development whereby



Fig. 1201.—TUBAL PREGNANCY. THE AMPULLARY PART IS DISTENDED WITH BLOOD CLOT. (Mus., R.C.S.)

the ovum is isolated and prevented from coming in contact with the maternal arterioles. Three mechanical factors are at work: (1) erosion; (2) enlargement of the embryo due to its growth; and (3) hæmorrhage due to the erosion of the maternal vessels. The capsular membrane, normally formed of decidua in uterine pregnancy, is made up of the connective and muscular tissues of the tube, the foetal sac being formed chiefly by the tube wall together with plastic lymph covering its surface and adhering to surrounding structures. The amnion and chorion develop as in uterine pregnancy.

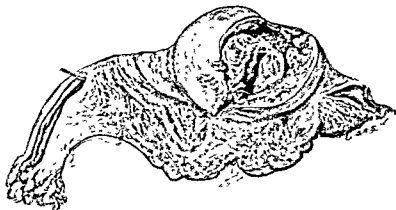


Fig. 1202.—TUBAL PREGNANCY. THE OVUM HAS BEEN IMPLANTED IN THE ISTHMUS. THIS PORTION OF THE TUBE IS SHOWN GREATLY EXPANDED TO A DIAMETER OF ABOUT ONE INCH. THE SWELLING IS LAID OPEN AND IS FOUND TO CONSIST OF LAYERS OF BLOOD CLOT, IN THE CENTRE OF WHICH ARE FOETAL MEMBRANES: THE WALL OF THIS PORTION OF THE TUBE WAS PERFORATED BY THE CHORIONIC VILLI WHICH COULD BE DEMONSTRATED ON MICROSCOPICAL EXAMINATION. (Mus., R.C.S.)

Intra-peritoneal rupture occurs in about 25 per cent of all cases of ectopic gestation. It is the usual result in isthmic implantation, taking place earlier than tubal abortion, namely, about the fourth or fifth week of gestation. Rupture is always the end-result in interstitial implantation and occurs much later, about the twelfth to the sixteenth week. It is of very infrequent occurrence when the embryo remains in the ampulla.

Rupture is brought about by erosion and hæmorrhage. The chorionic villi gradually erode their way through the tube wall and

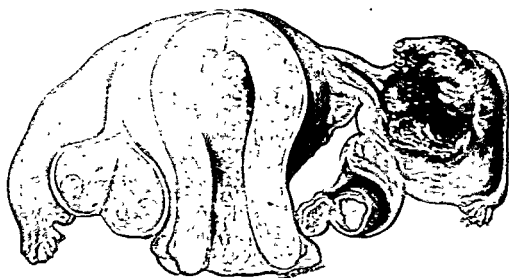


Fig 1292.—TUBAL PREGNANCY. UTERUS WITH BOTH TUBES AND OVARIES. IN THIS SPECIMEN THE OVUM HAD BEEN IMPLANTED IN THE ISTHMUS OF THE RIGHT FALLOPIAN TUBE. RUPTURE HAD OCCURRED FIRST IN THE BROAD LIGAMENT AND THEN INTO THE PERITONEAL CAVITY. CHORIONIC VILLI HAD COMPLETELY INVADDED THE TUBE WALL, INCLUDING THE PERITONEUM. A WELL-DEVELOPED CORPUS LUTEUM IS SHOWN IN THE RIGHT OVARY. THE LEFT OVARY CONTAINS A CORPUS ALBICANS. THE UTERUS IS ENLARGED THICKLY AND THE ENDOMETRIUM IS THICKENED. (M^{rs}, R.C.S.)

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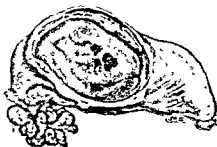


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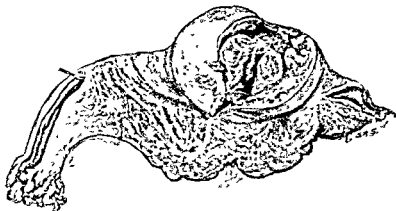


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On *microscopical* examination typical tuberculous giant-cell systems are seen in the tube wall and ovary.

Symptoms. These are indistinguishable from salpingo-oöphoritis. Menorrhagia is not always present, but when it occurs it is liable to be very severe and uncontrollable.

Diagnosis. The condition should be suspected when swellings can be felt in the posterior lateral fornices in adolescents and young virgins, if there is a history of tuberculous affection of the bowels or glands, or when there is gradual deterioration of health, loss of weight, persistent fever, and pelvic pain unrelieved by rest in bed.

Treatment. The tubes should always be removed by abdominal operation. Efforts must be made to conserve the ovaries or a part of one ovary, but in any case such a patient will be sterile. Hysterectomy is always indicated if the uterus is enlarged, congested, or if there has been menorrhagia, as it is highly probable that the endometrium is also affected. When dividing adhesions there is great risk of tearing the bowel, with resulting fistula formation. Serious or progressive tuberculosis of the lung is a contra-indication to operation.

TUBAL PREGNANCY

Extra-uterine or ectopic gestation is the arrest and development of a fertilised ovum at any point between the Graafian follicle and the endometrium.

The occurrence of primary abdominal pregnancy does not appear ever to have been proved. Ovarian implantation, although extremely rare, has been known to occur. Tubal pregnancy is the usual variety of ectopic gestation. The ovum may be implanted in the ampulla, the isthmus, or in the interstitial part of the tube; the first is the commonest, the last being very rare (figs. 1201, 1202 and 1203). Tubal and intra-uterine gestation have been known to occur together, and on rare occasions bilateral tubal implantation. The *cause* of arrest is unknown. Interference with its progress has been attributed to

kinking or spasm of the tube, the presence of polypi, congenital diverticula formed by inflammation, or the fact that the ovum is too large to pass along the lumen of the tube.

When the ovum comes to rest in any part of the tube it immediately burrows through the mucous membrane and comes to lie in the sub-mucosa; erosion continues into the musculature of the tube and blood-vessels, there being no compensatory decidual development whereby



Fig. 1201.—TUBAL PREGNANCY. THE AMPULLARY PART IS DISTENDED WITH BLOOD CLOT. (Mrs., R.C.S.)

the ovum is isolated and prevented from coming in contact with the maternal arterioles. Three mechanical factors are at work: (1) erosion; (2) enlargement of the embryo due to its growth; and (3) hæmorrhage due to the erosion of the maternal vessels. The capsular membrane, normally formed of decidua in uterine pregnancy, is made up of the connective and muscular tissues of the tube, the foetal sac being formed chiefly by the tube wall together with plastic lymph covering its surface and adhering to surrounding structures. The amnion and chorion develop as in uterine pregnancy.

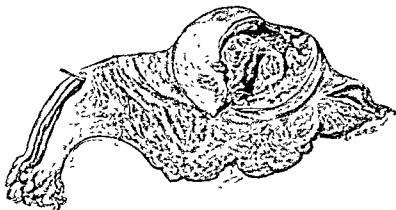


Fig 1202 —TUBAL PREGNANCY. THE OVUM HAS BEEN IMPLANTED IN THE ISTHMUS. THIS PORTION OF THE TUBE IS SHOWN GREATLY EXPANDED TO A DIAMETER OF ABOUT ONE INCH. THE SWELLING IS LAID OPEN AND IS FOUND TO CONSIST OF LAYERS OF BLOOD CLOT, IN THE CENTRE OF WHICH ARE FETAL MEMBRANES: THE WALL OF THIS PORTION OF THE TUBE WAS PERFORATED BY THE CHORIONIC VILLI WHICH COULD BE DEMONSTRATED ON MICROSCOPICAL EXAMINATION. (Mrs., R.C.S.)

The uterus enlarges in the usual way, rarely, however, attaining a size greater than that of 8-10 weeks' gestation.

Termination may be by tubal abortion, tubal rupture, or by mole formation.

Tubal abortion is the commonest termination, and occurs when there is ampullary implantation. The capsular membrane is stripped from

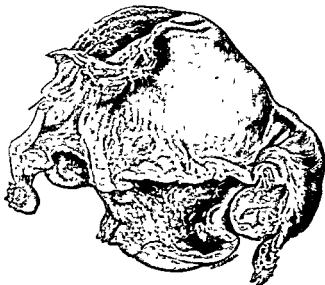


Fig. 1203.—TUBAL PREGNANCY. THE OVUM HAD BEEN ARRESTED IN THE INTERSTITIAL PART OF THE TUBE WITH THE RESULT THAT THE UTERINE CORNU HAD RUPTURED. THE SPECIMEN SHOWS THE UTERUS WITH BOTH TUBES AND OVARIES. THE LEFT CORNU OF THE UTERUS IS COMPLETELY REPLACED BY A LARGER RAGGED EXCAVATION FILLED WITH BLOOD CLOT. THE UTERUS WAS UNIFORMLY ENLARGED AND CONTAINED A DECIDUA. THE PATIENT WAS SUDDENLY SEIZED WITH SEVERE ABDOMINAL PAIN AND COLLAPSED AND DIED IN TWELVE HOURS. THE ABDOMEN CONTAINED SIX POUNDS OF CLOT AND FIVE PINTS OF FLUID BLOOD. (Mrs., R.C.S.)

its attachment as the result of hæmorrhage, and the ovum is expelled into the peritoneal cavity by contractions of the tube and by force of the hæmorrhage which always takes place. If bleeding is small in amount and occurs repeatedly, laminations of blood clot are deposited around the abdominal ostium and a *peri-tubal hæmatocele* is formed. When the bleeding is more profuse, a *pelvic hæmatocele* may develop and become encysted in the pouch of Douglas by adhesions forming round it (fig. 1204).

Tubal rupture may be intra-peritoneal (fig. 1205) or intra-ligamentous (fig. 1206).

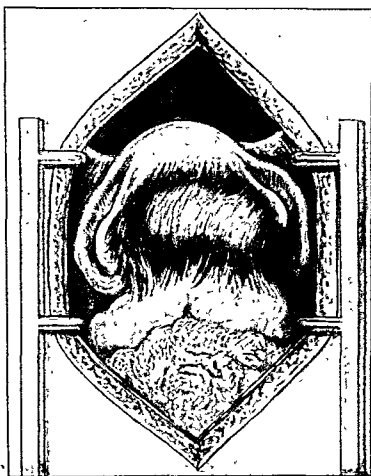


Fig. 1204.—TUBAL PREGNANCY. PELVIC HEMATOCELE. A LARGE MASS OF BLOOD CLOT IS SHOWN MATTING THE UTERUS AND BROAD LIGAMENTS TO COILS OF BOWEL. THE PELVIC CAVITY CONTAINS FLUID BLOOD.



Fig. 1205.—TUBAL PREGNANCY. THE TUBE AND OVARY ARE ADHERENT AND BOTH ARE FILLED WITH LAMINATED BLOOD CLOT. CHORIONIC VILLI HAVE GROWN THROUGH THE WALL OF THE TUBE IN ITS UPPER ASPECT. AN EMBRYO OF ABOUT SIX WEEKS' GROWTH LIES IN THE SAC. IN THE LOWER PART OF THE MASS OF BLOOD CLOT IS SHOWN A CORPUS LUTEUM. (*Mus., R.C.S.*)

Intra-peritoneal rupture occurs in about 25 per cent of all cases of ectopic gestation. It is the usual result in isthmic implantation, taking place earlier than tubal abortion, namely, about the fourth or fifth week of gestation. Rupture is always the end-result in interstitial implantation and occurs much later, about the twelfth to the sixteenth week. It is of very infrequent occurrence when the embryo remains in the ampulla.

Rupture is brought about by erosion and hæmorrhage. The chorionic villi gradually erode their way through the tube wall and

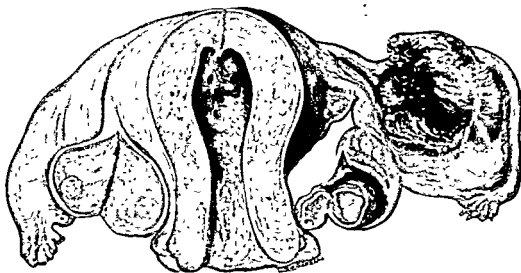


Fig. 1204.—TUBAL PREGNANCY. UTERUS WITH BOTH TUBES AND OVARIES. IN THIS SPECIMEN THE OVUM HAD BEEN IMPLANTED IN THE ISTHMUS OF THE RIGHT FALLOPIAN TUBE. RUPTURE HAD OCCURRED FIRST INTO THE BROAD LIGAMENT AND THEN INTO THE PERITONEAL CAVITY. CHORIONIC VILLI HAD COMPLETELY INVADDED THE TUBE WALL, INCLUDING THE PERITONEUM. A WELL-DEVELOPED CORPUS LUTEUM IS SHOWN IN THE RIGHT OVARY. THE LEFT OVARY CONTAINS A CORPUS ALBICANS. THE UTERUS IS ENLARGED UNIFORMLY AND THE ENDOMETRIUM IS THICKENED. (M^{rs}, E.C.S.)

maternal blood-vessels (see fig. 1205), hæmorrhage occurs with ever increasing pressure, and finally the tube is disrupted, probably with further laceration of blood-vessels. Hæmorrhage is usually profuse. When this occurs in small repeated attacks layers of blood clot are formed around the impregnated part of the tube—*para-tubal hæmatocele*.

Intra-ligamentous rupture (fig. 1206). The tube wall bursts on its lower aspect and the attendant hæmorrhage results in a broad ligament hæmatoma.

Rupture is frequently preceded by the formation of either a tubal mole (see fig. 1201), hæmorrhage having stripped the chorion from the

capsular membrane, or hæmatosalpinx when hæmorrhage distends a tube, the ostium of which has previously been sealed.

In all cases of abortion or rupture the embryo may be partially or completely detached; when the latter, the embryo usually dies. Should the amnion remain intact, however, and the chorion have

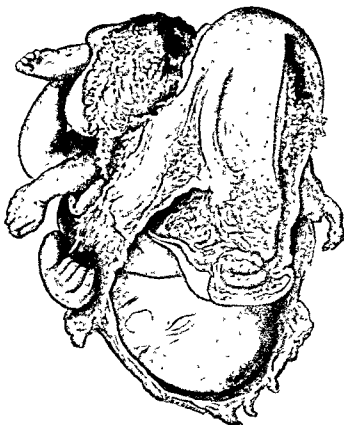


Fig. 1207.—TUBAL PREGNANCY WITH SECONDARY ABDOMINAL PREGNANCY OF 32 WEEKS. THE UTERUS WAS ABOUT FIVE INCHES LONG CONTAINING A WELL-FORMED DECIDUA. IMPLANTATION OF THE OVUM HAD OCCURRED IN THE LEFT TUBE AND RUPTURE HAD TAKEN PLACE INTO THE LEFT BROAD LIGAMENT. THE EMBRYO CONTINUED TO GROW RETROPERITONEALLY, LIFTING UP THE PERITONEUM OF THE POUCH OF DOUGLAS AND THE POSTERIOR LAYER OF THE BROAD LIGAMENT. THE GESTATION SAC LAY IN CONTACT WITH THE FRONT OF THE RECTUM. SECONDARY RUPTURE OF THE GESTATION SAC OCCURRED WITH EXTENSIVE HÆMORRHAGE INTO THE PERITONEAL CAVITY, FOLLOWED BY THE DEATH OF THE PATIENT. (M^{rs.}, R.C.S.)

sufficient blood supply to keep the embryo alive until new vascular connections are established, the embryo may survive and grow as a secondary abdominal or intra-ligamentous gestation.

Secondary abdominal gestation. The amnion becomes covered with lymph which organises and adheres to surrounding structures, forming a fresh sac. The chorionic villi become attached to the back of the uterus, broad ligament, rectum, small bowel or pelvic wall, and the

placenta develops in this new situation. The pregnancy may proceed to term, or a secondary hæmorrhage may occur stripping all connections and resulting in the death of the embryo.

Secondary ligamentous gestation results when the extruded embryo survives and grows between the layers of the broad ligament, the placenta developing an attachment to the pelvic connective tissues. As the embryo grows, the peritoneum becomes stripped off the anterior abdominal wall and bladder or off the side wall of the pelvis towards the mid-line posteriorly, pushing the rectum to the opposite side; in this way the sac may lie either in front of or behind the uterus.

Hæmatocele and secondary gestation sacs. A pelvic hæmatocele may become absorbed or infected, the infection being due to streptococci or *B. coli* gaining entrance from the adherent bowel, resulting in the formation of an abscess which may rupture into the bowel or bladder. *Suppuration* is always associated with high fever, sweating, rapid wasting and exhaustion, and unless relieved by operation or spontaneous rupture into the bowel, the patient may die. When a *secondary gestation sac* forms, the foetus may die at any stage, or pregnancy may proceed to term, when there will be painful uterine contractions, the endometrium will be shed (false labour), and the foetus will die (fig. 1207). In either case the sac may become infected or may calcify. *Calcification* results from the deposition of lime salts in the sac wall, or occasionally in the foetus, resulting in the formation of a *lithopædion* which may remain in the abdomen unrecognised for many years.

SYMPTOMS AND SIGNS

(1) *Before rupture or abortion.* A classical history of amenorrhœa, one or two periods having been missed, is present in about 40 per cent of cases. Almost invariably, however, the last period is early or late in onset, shorter in duration, and the loss smaller than usual. Pain is always present in one or other side of the lower abdomen, constant in character, but with attacks of increasing severity. Indigestion, nausea and morning vomiting are usually present, and a tingling sensation and a feeling of fulness in the breasts are also noted.

Examination reveals marked tenderness on one or other side of the abdomen and in one of the vaginal fornices. The cervix may be a little softer than normal, and the uterus slightly enlarged, softened, and extremely tender on manipulation. On account of extreme tenderness

the enlarged tube can never be felt unless the examination is made under anæsthesia.

(2) *When there is tubal abortion.* Pain, at first severe and colicky in character and later becoming continuous, is felt in the lower abdomen, but may be referred to the upper abdomen, the chest or shoulders. There is faintness, vomiting, the pulse is rapid, and the temperature normal or sub-normal. *The lower abdomen and vaginal fornices are extremely tender to pressure; this pronounced tenderness, due to blood in the peritoneal cavity, is a most important sign.*

When hæmorrhage has been severe, there will also be general pallor, anxious facies, sweating and restlessness. Signs of fluid in the peritoneal cavity may be present, and an exquisitely tender cystic swelling in the posterior fornix, lifting the uterus upwards and forwards, may also be detected. There will be uterine bleeding in 80 per cent of cases; in about 20 per cent the blood is bright red; in other cases there is a brownish discharge. The endometrium is shed, either as a complete cast, or as shreds which may possibly escape notice. The cast is usually thick, white, shiny on the inner surface, but not mixed with blood clot. Microscopically it consists of decidual cells and uterine glands.

(3) *When there is tubal rupture.* Pain is always continuous, sudden in onset and severe, otherwise the symptoms and general signs are the same as in tubal abortion but tending to be more pronounced as rupture is nearly always associated with sudden and severe bleeding. After the initial shock most cases recover quickly, at least for a short time, but sometimes all the symptoms increase and the patient dies.

(4) *When there is para- or peri-tubal hæmatocoele,* a condition not infrequently encountered, there are severe attacks of pain in the lower abdomen, sometimes coming on after exertion. Irregular uterine bleeding or brown discharge also occurs. Abdominal and vaginal examination reveal the same pronounced tenderness as in rupture or abortion. Occasionally a large hæmatoma forms which may be palpable per abdomen or on bimanual examination as a markedly tender swelling.

(5) *When there is secondary abdominal pregnancy* there will be some of the usual symptoms of pregnancy. Foetal parts can often be felt with great ease. Abdominal pain is always present as the result of

plastic peritonitis, and uterine bleeding or brownish discharge is also common. At term there are attacks of spasmodic pain, shedding of the endometrium as a cast or shreds—false labour, and death of the foetus. When suppuration occurs all the symptoms of fever will be superadded.

DIFFERENTIAL DIAGNOSIS

(1) *Uterine abortion*. Bleeding is usually free, pain slight, and abdominal and pelvic tenderness absent.

(2) *Chronic salpingo-oöphoritis (pyosalpinx)*, with small repeated hæmorrhages, may present signs and symptoms indistinguishable from tubal abortion.

(3) *Torsion of an ovarian cyst*. Uterine bleeding is absent, the pulse and temperature may be normal or only slightly raised, and a cystic swelling may be felt on abdominal or vaginal examination.

(4) *Appendicitis*. Only when the appendix hangs over the brim of the pelvis will difficulty in diagnosis arise. There is no uterine bleeding, temperature and pulse are raised, and leucocytosis (12,000 to 20,000) is often present. Almost invariably there is some tenderness and rigidity in the right iliac fossa.

(5) *Ruptured gastric or duodenal ulcer*. There is usually a past history of peptic ulcer, and acute pain is always felt in the upper abdomen. Muscular rigidity is inflexible and tonic, and tenderness is chiefly limited to the upper abdomen. There is no uterine bleeding, and in early cases rectal and vaginal examination may reveal no tenderness.

PROGNOSIS

Operative treatment has reduced the mortality from 97 per cent to a little over 3 per cent. The prognosis of tubal abortion is much more favourable than that of tubal rupture. The outlook for a case of ruptured interstitial pregnancy is grave.

Pregnancy in a rudimentary uterine horn. The symptoms and signs of this condition are similar to those of tubal gestation. Rupture is the rule, occurring at a later period than tubal pregnancy. Occasionally cases are said to have gone to full term.

Treatment. The treatment of ruptured ectopic gestation is always operative (see page 2554).

NEW GROWTHS OF THE TUBE

Primary tumours are exceedingly rare; secondary growths are due to carcinoma of the ovary, uterus, stomach, intestine or breast (fig. 1208).

The only benign new growth is adenoma. The malignant growth is columnar-celled carcinoma.

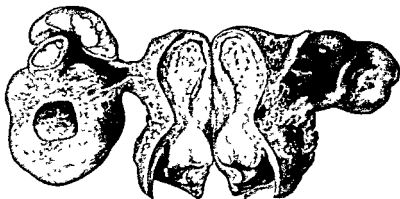


Fig. 1208.—SECONDARY CARCINOMA OF THE FALLOPIAN TUBE. THE PRIMARY GROWTH WAS A COLUMNAR-CELLED CARCINOMA OF THE BODY OF THE UTERUS WHICH HAD ALSO SPREAD TO THE CERVIX. (Mus., R.C.S.)

Adenoma is a growth of the epithelium with gland-like acini, occasionally with papillary outgrowths; the lumen is distended and sometimes the growth projects from the ostium abdominale. Histologically it is a true adenoma. Ascites and occasionally blood-stained uterine discharge are the only symptoms. The condition is rarely diagnosed before operation, treatment being removal of the tube.

Carcinoma is also extremely rare and is of the columnar-celled adeno-carcinomatous type. A blood-stained uterine discharge is the only symptom and may lead to an examination which will reveal a swelling in the neighbourhood of one of the tubes. The prognosis is very bad, and removal of both ovaries and the uterus is the only treatment recommended.

PELVIC CELLULITIS (PARAMETRITIS)

This is an acute inflammation in the areolar tissues of the broad or utero-sacral ligaments. Infection may spread from the uterine cavity via the lymphatics, but more commonly arises as the result

of deep lacerations of the cervix extending through the vaginal vault and opening up the base of the broad ligament. Usually the condition is unilateral, a swelling forming by the side of the uterus due to infiltration of the cellular tissues with serum and leucocytes. In mild cases the process may subside or suppuration may occur and an abscess form which may burst into the bladder, rectum or vagina. Sometimes the inflammation spreads to the iliac fossa, lifting up the peritoneum and causing a swelling above the inner or outer half of Poupart's ligament. On rare occasions pus spreads along the sheath of the psoas muscle to the perinephric region, under Poupart's ligament to the inner side of the thigh, through the sacro-sciatic foramen, or along the round ligament to the groin. Most frequently the abscess points above Poupart's ligament in its outer half. Occasionally organisms enter the blood stream causing a fatal septicæmia. When the utero-sacral ligaments are affected, an abscess may form and burst into the rectum.

Symptoms. The onset is usually gradual, occurring with fever and pelvic pain towards the end of the second week of the puerperium, or rarely following a gynæcological operation. There is tenderness in the hypogastrium and behind or to one side of the uterus. The vaginal vault is depressed. Later an indurated zone can be felt above the outer half of Poupart's ligament. When suppuration occurs a fluctuating mass may be felt immediately above Poupart's ligament or in the base of the broad ligament. Healing results in the formation of cicatricial induration in the broad or utero-sacral ligament, which is the source of much subsequent pain which increases before menstruation.

Treatment. In the early stages this is palliative. Copious hot douches, glycerine pessaries, and fomentations to the lower abdomen are efficacious. When suppuration occurs the abscess should be opened by Hilton's method. Usually the incision is made above the outer half of Poupart's ligament. Sometimes the abscess may be drained through the vaginal vault.

SECTION 2

GYNÆCOLOGICAL OPERATIONS

by
J. LYLE CAMERON

CHAPTER I

PRE-OPERATIVE INVESTIGATIONS AND TREATMENT

If the condition is non-acute, the patient should be kept in bed for at least twenty-four hours before operation is performed.

Investigation of the following must be undertaken :

(1) *Cardio-Vascular System.* The majority of cardiac disorders are not a bar to major operations or to general anæsthesia.

Patients with valvular disease stand operations well when compensation is adequate. Signs of fatty degeneration of the heart muscle may be vague, but obesity, poor soft muscles, distant heart sounds, and small pulse pressure may suggest the presence of this serious condition. Patients suffering from chronic intoxications—septic, alcoholic, or metabolic—must be regarded as bad operative risks. Patients with high blood-pressure usually stand operations well, unless these are prolonged or severe.

(2) *Blood Conditions.* Anæmia may be produced by repeated hæmorrhages or by constant bleeding for many weeks or months, but unless of a pronounced type it is seldom a contra-indication to operation. There is greater danger, however, of acute septic endophlebitis and pulmonary embolism. Pre-operative blood-transfusions, treatment with liver extract, dried extracts of stomach, iron and arsenic, copper, etc., should be administered, and careful watch maintained for a possible repetition of the hæmorrhage, which might deprive the patient of the benefits of the treatment.

A complete blood examination should be made in all cases of anæmia, as uterine hæmorrhage may be due to thrombocytopenic

purpura hæmorrhagica, one of the leucæmias, or some other blood dyscrasia.

(3) *Respiratory Diseases.* In acute respiratory affections such as bronchitis, operation must be postponed until the condition has completely subsided, as broncho-pneumonia or even lobar pneumonia may follow the administration of the anæsthetic. Inhalation anæsthetics should be avoided if there is chronic bronchitis or pulmonary tuberculosis, and when operation is imperative in such cases a basal anæsthetic, followed by a spinal, is advised.

(4) *Renal Conditions.* Here a complete examination of the urine may be necessary, and in certain cases an estimation of the blood urea and blood chlorides. Where the urinary symptoms are marked cystoscopy should never be omitted.

(5) *Diabetes* is no longer a contra-indication to operation, as the disease can be controlled to some extent by diet and insulin (see page 790).

(6) *Obesity.* Fat patients are more liable to complications, such as post-operative infection of the wound, burst abdomen, phlebitis, thrombosis and pulmonary embolism. Fat in the abdominal wall, in the extra-peritoneal tissues (as in the iliac fossæ and lateral to the bladder), and in the appendices epiploicæ, greatly increases the difficulty of all pelvic manipulations. When time permits, the patient should be put on a carefully chosen diet which will reduce weight without diminishing vitality.

(7) *Emaciation.* Patients who are wasted as a result of starvation or chronic intoxication are not good operative risks, and a diet rich in carbohydrates, injections of insulin, and sometimes glucose administered intravenously, may be prescribed in such cases.

(8) *Thyrotoxicosis.* This condition may cause sudden death during operation, or give rise to uncontrollable tachycardia with heart failure subsequent to operation.

(9) *Insanity* is not a contra-indication, and mental cases usually stand operation well, but the guidance of a mental specialist should always first be sought.

(10) *Pregnancy.* The possibility of pregnancy must never be forgotten when contemplating any gynæcological operation, as pregnancy is a contra-indication to most operations, except in cases of great urgency, e.g. acute appendicitis.

PRE-OPERATIVE TREATMENT

(1) General.

(2) Local.

General Pre-operative Treatment. The patient should be kept in bed for 24 to 48 hours prior to a major operation. This gives opportunity for completing the investigations, and for general pre-operative treatment to be undertaken. Two factors of importance are the relief of pain and the promotion of sleep. When a diagnosis has been made and the type of operation decided upon, pain is no longer a useful diagnostic symptom, and if left unrelieved will further reduce the patient's strength. Pain which is not appeased by aspirin or barbiturate drugs demands morphia, $\frac{1}{6}$ – $\frac{1}{4}$ gr. Prior to operation the patient usually suffers from anxiety and consequent insomnia, and sedatives such as bromides should be given in the early evening, being later followed by medinal 5 grs. or chloral hydrate 15 grs..

Local Pre-operative Treatment: (a) abdominal, (b) vaginal.

Abdominal. Shaving of the abdominal wall, pubes and vulval region is essential, followed by cleansing the skin and preparing it for operation by the application of an antiseptic such as picric acid 3 per cent in 65 per cent alcohol, iodine 2 per cent solution in 65 per cent alcohol, tannin-alcohol, tinct. metaphen (Abbott), or Bonney's violet-green solution, the disinfected area then being covered with a sterile towel.

Vaginal. As a general rule, the pubic, vulval and peri-anal regions are shaved. For some of the lesser operations the hair over the mons should be clipped short and only the vulva shaved. The patient then has a bath, soap being applied freely to the vulval and peri-anal skin, after which a douche of dettol (2 drachms to the pint) is given, three quarts of the solution being used at 112 to 115 degrees F. After the douche, the vulval, pubic and peri-anal regions and the skin on the inner aspect of the thighs are cleansed with ether soap, thoroughly rinsed and dried. The vagina is further disinfected, and packed for six hours before operation with a strip of gauze soaked in pure eusol or violet-green solution.

IMMEDIATE PRE-OPERATIVE PREPARATION

Abdominal. When the patient is on the operating table the abdomen, pubes and the skin in front of the thighs are thoroughly painted with the antiseptic solution originally used.

Vaginal. The eusol plugging is removed when the patient is in the lithotomy position. The skin of the vulva, the suprapubic and perianal regions, and the inner aspects of the thighs are painted with the antiseptic. A swab is then soaked in the antiseptic and applied to the whole interior of the vagina.

When operations are performed upon the cervix or uterine cavity, after the cervix has been fixed with a vulsellum, the external os and entrance to the cervical canal are wiped with dry gauze held with the uterine forceps, to remove all mucus and to empty the superficial portion of the gland ducts. A pack is placed in the posterior fornix to prevent the antiseptic, which is strong, from coming into contact with the vaginal mucosa. A 10 per cent solution of picric acid in absolute alcohol is then applied to the external os and cervical canal; this is rubbed well into the surface and the swab is allowed to remain *in situ* for a minute or two.

Purges must be avoided. It is better to administer an ordinary soap and water enema about 12 hours before the operation, but not later, especially prior to vulvo-vaginal operations, as, during the anæsthetic, the sphincter ani relaxes and the liquid contents of the bowel are liable to escape and add to the risks of wound contamination.

EMERGENCIES

In cases of emergency, preparation may be made after the anæsthetic has been given. The abdomen, pubes and surrounding regions are cleansed with methyl-ether, dry shaved, and the antiseptic solution applied.

CHAPTER II

GENERAL COMMENTS ON THE TECHNIQUE OF GYNÆCOLOGICAL OPERATIONS

POSITIONS FOR GYNÆCOLOGICAL OPERATIONS

- (1) Trendelenburg.
- (2) Dorsal.
- (3) Lithotomy.
- (4) Lithotomy-Trendelenburg.

(1) *The Trendelenburg position* is the one usually employed for all abdominal gynæcological operations, the main advantage being that the intestines and great omentum gravitate away from the pelvis towards the upper abdomen. The patient is placed on her back on the table, the leg-piece of which is lowered so that her legs are flexed at a right angle to the thighs; the head of the table is then lowered so that the knees occupy the highest position. The patient is prevented from slipping off the table either by having her weight carried on shoulder braces, or by strapping the flexed legs. The foot-piece of the table is then lowered, a suitable pad having been placed under the upper part of each leg below the knee, and a strap fixed over the ankles and around the foot-piece of the table. The head-piece of the table should be flexed a few degrees to relax the abdomen. On no account should the supported arms ever be extended above the head when using the shoulder braces, as injury to the fifth and sixth cervical nerves is liable to result.

The Trendelenburg position should not be used when there is danger of pus or septic fluid gravitating from the pelvis to the upper abdomen.

(2) *In the Dorsal position* the patient lies flat on her back, the legs and thighs being in line with the body. The arms lie extended by her sides, and should be maintained in position by a draw-sheet, the ends of which are folded over the arms and then tucked under the back. This is the position used when large pelvic tumours, such as ovarian cysts, are to be removed, or when there is pus or septic fluid that might gravitate upwards in the abdomen.

(3) *In the Lithotomy position* the patient lies flat on her back with the buttocks about 2 inches beyond the foot of the table. The thighs are flexed on the abdomen and abducted, and the legs are flexed on the thighs. The position is maintained by the use of some support, such as a lithostat, or by upright posts which are fixed on each side of the table and to which the feet are attached. This position is required for all operations on the vulva, the vagina, or on the uterus or pelvic viscera via the vaginal route. In the lithotomy position the patient's arms should be folded over the chest.

(4) *The Lithotomy-Trendelenburg position* is a combination of positions (1) and (3), and may be employed when vaginal operations are performed.

INSTRUMENTS

Instruments used in gynecological operations are on the whole rather heavier than those used in other branches of surgery. Many variations are possible, but a list which covers the armamentarium for most operations is:

1. SCALPEL.

Long-bladed.

2. SCISSORS.

7" Mayo dissecting pattern. One straight, one curved on flat (fig. 1209).

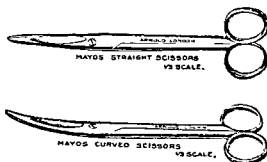


Fig. 1209.—MAYO'S SCISSORS; THE BLADES TAPER TO THE POINT WHICH IS ROUNDED AND NOT SHARP.

3. FORCEPS.

- (i) *Dissecting*. These are 7" long with roughened surface for the gloved fingers, and rat-toothed points with serrations above to allow grasping of a needle.
- (ii) *Artery*. Light and heavy Maingot forceps. Maingot's heavy forceps are 8" long, slightly curved, and with rat-toothed points. A deep groove in one blade takes a tongue from the opposite side and prevents tissues from slipping laterally through the blades (figs. 1210 and 1211).

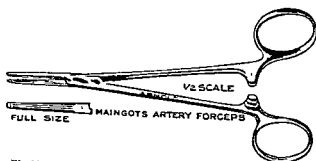


Fig. 1210.—MAINGOT'S SMALL ARTERY FORCEPS. THE JAWS ARE GROOVED LONGITUDINALLY.

- (iii) *Ring*. These serve to hold swabs or to lift a mass of tissue without crushing it.
- (iv) *Uterine*. The author's modification of Bozeman's forceps is 14" long and has a double curve. It serves for packing the uterus or vagina, painting the cervix, or introducing a drainage-tube (fig. 1212).

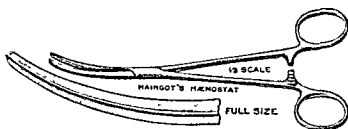


Fig. 1211.—**MAINGOT'S HÆMOSTATIC FORCEPS.** THIS INSTRUMENT IS ESPECIALLY CONSTRUCTED TO PREVENT VESSELS OR TISSUES FROM SLIPPING Laterally OUT OF THE JAWS.



Fig. 1212.—**LARGE UTERINE FORCEPS.** THIS INSTRUMENT IS USED FOR SWABBING THE CERVIX, PACKING THE UTERUS AND VAGINA, OR INTRODUCING A DRAINAGE-TUBE INTO THE PELVIS, ETC.

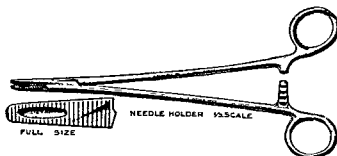


Fig. 1213.—**LONG-HANDLED NEEDLE HOLDER.** (MAYO'S PATTERN.)

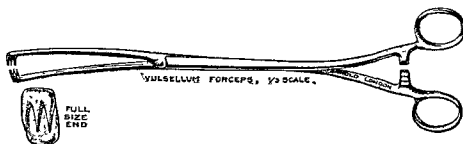


Fig. 1214.—**LARGE VULSELLUM FORCEPS.**



Fig. 1215.—**FENTON'S VULSELLUM.**

4. NEEDLE HOLDER.

Figure 1213 shows a serviceable pattern 10" long, with springy shanks and wide finger rings.

5. VULSELLUM.

Modified Kelly pattern, 12" long, with large teeth which afford a powerful grip and do not tear through the tissues (fig. 1214).

Fenton's pattern can be used to grasp a small cervix, or one nearly flush with the vaginal vault (fig. 1215).

6. UTERINE SOUND.

Simpson's sound has a globular tip and graduations whereby the length of the uterine cavity can be estimated (fig. 1216).



24 UTERINE SOUND VS SCALE.

Fig. 1216.—UTERINE SOUND.

7. BLADDER SOUND.

Large size with rounded end (Liston).

8. UTERINE DILATORS.

Three patterns are commonly used :

(a) Fenton's, with double tapered ends.

(b) Hegar's, with a steep tapering end (fig. 1217).

(c) Ramsay's, which has a tapering end and is hollow.



HEGAR'S DILATOR

Fig. 1217.—HEGAR'S DILATOR.

9. CURETTES.

Figure 1218 shows a double-ended type. One end is straight and $\frac{3}{4}$ " wide, the other rounded and $\frac{1}{4}$ " wide. This smaller end can be used to explore the uterine cornua thoroughly.



245 UTERINE CURETTE VS SCALE.

Fig. 1218.—UTERINE CURETTE WITH LARGE AND SMALL BLADE. THE SHARP EDGE OF EACH SLOPES TOWARDS THE HANDLE.

10. SHARP SCOOP.

Sharper and more powerful than the curette. Used for scraping the cervix and removing polypi.

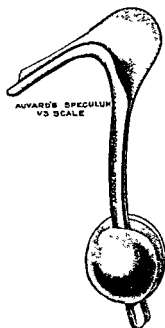


Fig. 1219.—AUVARD'S WEIGHTED
SELF RETAINING VAGINAL
SPECULUM.

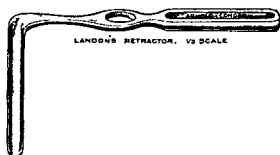


Fig. 1220.—NARROW VAGINAL RETRACTOR (Landon's).
THIS IS USED TO ELEVATE THE BLADDER WHEN PERFORM-
ING VAGINAL HYSTERECTOMY AND INTERPOSITION OPERA-
TIONS, AND ALSO TO FACILITATE PACKING THE VAGINA, AND
FOR MAKING VAGINAL EXAMINATIONS.

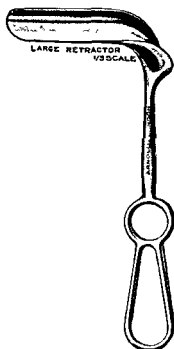


Fig. 1221.—LARGE VAGINAL RE-
TRACTOR FREQUENTLY USED WHEN
PERFORMING VAGINAL HYSTEREC-
TOMY, OR WHEN EXPLORING THE
VAGINAL VAULT AND CERVIX. THIS
MODEL GIVES A FREE EXPOSURE OF
THESE PARTS.

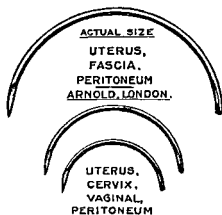


Fig. 1222.—NEEDLES. ROUND-BODIED WITH
THREE CORNERED ENDS OR TROCAR POINTS.
NEAR THE EYE THE BODY OF THE NEEDLE IS
FLATTENED TO FACILITATE GRASPING WITH A
NEEDLE HOLDER.

11. SPECULUM.

Auvard's weighted speculum is used in most vaginal operations (fig. 1219). It holds heat for a long time after boiling and may therefore have to be cooled before use.

12. NARROW RETRACTOR.

A blade 1" wide and 4" long set at right angles to a handle (fig. 1220) serves to hold the bladder or perineal body out of the way when a good exposure of the cervix is required.

13. WIDE RETRACTOR.

As above, but with a blade 2½" wide which is used to elevate the bladder during the operation of vaginal hysterectomy (fig. 1221).

14. TOWEL CLIPS.

15. NEEDLES.

A relatively heavy type of needle is advisable for most work in the pelvis. Half-circle trocar-pointed needles (sizes 1 to 3) fulfil most requirements (fig. 1222).

16. SUTURE MATERIAL.

Plain No. 00 catgut is adequate for ligaturing blood-vessels in the subcutaneous tissues.

No. 00 20-day chromicised catgut is used for intestinal sutures and for inserting blanket stitches in the ovary after enucleation of a cyst.

No. 1 20-day chromicised catgut can be recommended for most abdominal and cervical operations.

No. 1 plain catgut is employed for vaginal repair operations.

Silkworm-gut is suitable for skin sutures.

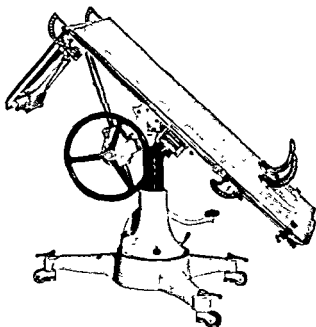


Fig. 1223.—OPERATING TABLE ADJUSTED FOR THE TRENDLENBURG POSITION.

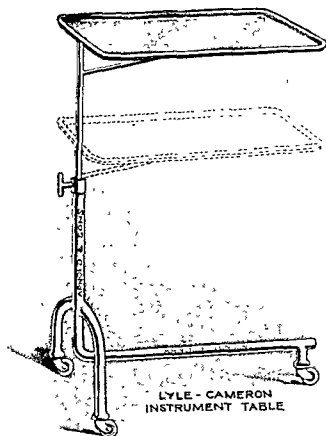


Fig. 1224.—LITHOTOMY INSTRUMENT TABLE. THE TRAY IS 30 INCHES LONG AND 9 INCHES WIDE. THE TABLE CAN BE ADJUSTED TO HEIGHTS VARYING FROM 1 FOOT TO 2 FEET FROM THE FLOOR.

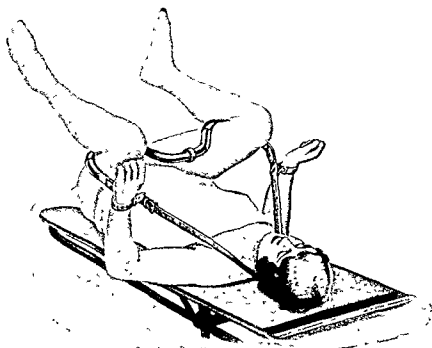


Fig. 1225.—OX-YOKE CRUTCH OR LITHOSTAT (THACKERAY).

17. OPERATING TABLE.

The model in figure 1223 shows the angles required for the Trendelenburg position.

18. LITHOTOMY INSTRUMENT TABLE.

This table, designed by the author, is most convenient for use in all vulvo-vaginal operations. It can be adjusted to any height. The tray is 30" x 9" (fig. 1224).

19. OX-YOKE CRUTCH OR LITHOSTAT.

This serves to maintain the patient in the lithotomy position when a fully equipped operating table is not available (fig. 1225).

INSTRUMENTS REQUIRED FOR ABDOMINAL GYNÆCOLOGICAL OPERATIONS

A general list of instruments used for all cases is here given. Special instruments will be mentioned in the description of the particular operation for which they are required.

2 Scalpels.

2 Pairs of Mayo scissors—straight and curved.

2 Pairs of toothed dissecting forceps—long and short.

12 Pairs of artery forceps.

4 Pairs of Allis forceps.

2 Ring forceps.

1 Vulsellum.

1 Self-retaining retractor.

2 Hand retractors.

6 Towel clips.

1 Needle holder.

2 Pairs of Gray towel clips.

2 Dozen skin clips—Kifa or Michel.

Toothed forceps with rack for clips.

Needles: Trocar-pointed, 3 of each, sizes Nos. 1, 2 and 3; and 3 long straight cutting needles.

Catgut: Nos. 1 and 00 20-day chromicised, and plain.

Silkworm-gut.

Assorted sizes of rubber drainage tubing.

INCISIONS FOR ABDOMINAL GYNÆCOLOGICAL OPERATIONS

There is a choice of three incisions:

(1) Right paramedian.

(2) Mid-line.

(3) Transverse.

(1) *Right Paramedian Incision* (fig. 1226). *Indications.* The right paramedian incision is employed when a large opening is necessary for removing massive tumours, or for affording easy access to the depths of the pelvis when performing total hysterectomy, radical hysterocolpectomy, or dividing extensive adhesions of the uterus and adnexa.

The advantages are that the aponeurosis is divided down the centre of the anterior aspect of the rectus muscle and the peritoneum is opened behind the muscle which, when the operation is completed, comes to lie between the two suture lines and affords an added barrier against subsequent incisional hernia.

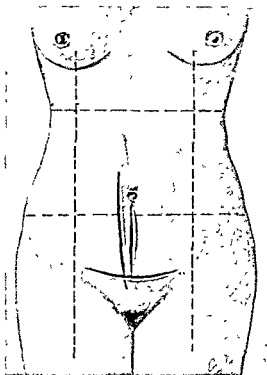


Fig. 1226.—THE USUAL SURFACE MARKINGS AND THE THREE TYPES OF INCISIONS ARE SHOWN. THE RIGHT PARAMEDIAN INCISION EXTENDS ABOVE THE UMBILICUS AND DOWN TO THE SYMPHYSIS PUBIS, AND LIES OVER THE CENTRE OF THE RIGHT RECTUS MUSCLE. THE MID LINE INCISION EXTENDS FROM THE SYMPHYSIS PUBIS UPWARDS TO THE UMBILICUS. THE TRANSVERSE INCISION IS SLIGHTLY CURVED WITH CONVEXITY DOWNWARDS, AND LIES PARALLEL WITH AND ABOVE THE UPPER BORDER OF THE PUBES AND THE INNER ENDS OF POUPART'S LIGAMENTS.

The skin incision, beginning on a level with and one inch to the right of the umbilicus, is carried downwards, turning towards the mid-line at the lower end. It is deepened through the adipose layer down to the aponeurosis, which is cleared of fat for a distance of about a quarter to half an inch on each side of the proposed line of division. The aponeurosis is cut over the centre of the rectus muscle in the upper two-thirds of the incision which then inclines towards the mid-line in the lower third, so that the inferior end will be medially placed at the symphysis. This opening should be carried as low down as possible, thereby affording maximum access to the pelvic cavity. Both edges of the aponeurosis are undermined, that on the inside

being completely separated from the muscle, which is retracted outwards, the peritoneum being opened in a vertical line behind the muscle.

(2) *Mid-line Incision* (see fig. 1226). This incision opens directly between the recti muscles, which are easily separated. It is a very satisfactory method of approach when small openings are required, e.g. when ventro-fixation or round ligament suspension of the uterus is to be performed. The incision is carried through the skin and fat from below the umbilicus down to the symphysis. The aponeurosis when reached is cleared of fat for a short distance on each side of the mid-line and then divided along the linea alba. The recti muscles are separated and the peritoneum is opened vertically in the mid-line.

(3) *Transverse Incision* (see fig. 1226). The only advantage in the use of this incision is a cosmetic one, as the scar lies within the area covered by pubic hair by which it is subsequently hidden.

The disadvantage of this incision is that the opening thus obtained is small and access is restricted. It should be used only for such operations as ventro-fixation, round ligament shortening, or the removal of small ovarian tumours.

The incision, which is four to five inches long, is made transversely one finger-breadth above the pubic bones and passes through the skin and subcutaneous fat. The aponeurosis may be divided either vertically or transversely.

Vertical Division. The central part of the skin above the incision is retracted upwards, and the aponeurosis and peritoneum are divided vertically in the mid-line as in the ordinary median incision.

Transverse Division. The aponeurosis is divided transversely in line with the skin incision. The upper side of both aponeuroses and skin are pulled upwards, the recti muscles are drawn apart laterally, and the peritoneum is divided vertically.

OPENING THE ABDOMINAL CAVITY (CÆLIOTOMY)

The length and exact position of the incision being determined, four or five transverse scratches are made with a needle or with the point of a knife, to assist in accurate approximation of the edges (fig. 1227).

The length of the incision, usually about six inches, will depend on the size of the tumour to be removed, the amount of fat on the abdominal wall, and the exposure required.

The skin is cut by a swift steady stroke from the point chosen at the upper end to a point level with the upper margin of the symphysis, and the fat is incised down to the aponeurosis. The aponeurosis is divided throughout the full length of the incision (fig. 1228). If it is a right paramedian incision, the underlying rectus muscle will be exposed; if a median, the extra-peritoneal fat between the recti muscles will come into view. When the former incision is used, some difficulty may arise in finding the medial border of the rectus.

An unfailing guide to the inter-rectal space is the umbilicus and an imaginary line running vertically downwards from it. Dissection should be made towards this line until the medial border of the rectus is reached; the muscle is then separated from its sheath.

On no account should the rectus muscle be split longitudinally, as if this is done the abdominal opening cannot be retracted satisfactorily.

The recti having been retracted laterally, the extra-peritoneal fat is divided and the shining peritoneum is exposed with the urachus running as a white cord on its deep surface. The peritoneum is picked up and divided for the whole length of the incision, care being taken to avoid injury to the bladder, the underlying intestines, or an adherent tumour (fig. 1229).

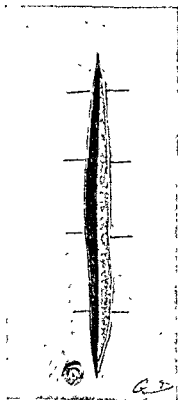


Fig. 1227.—RIGHT PARAMEDIAN INCISION. CROSS SCRATCHES HAVE BEEN MADE ON THE SKIN WITH A NEEDLE AND THE SKIN AND SUBCUTANEOUS FAT HAVE BEEN DIVIDED.

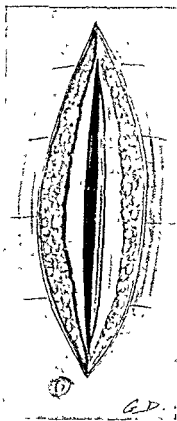


Fig. 1228.—RIGHT PARAMEDIAN INCISION. THE APONEUROSIS ON THE FRONT OF THE RECTUS MUSCLE HAS ALSO BEEN DIVIDED.

Two fingers of the left hand, with their flexor surface upwards, are inserted through the wound to lift the peritoneum upwards and facilitate the division of the peritoneum right down to the bladder. Using the handle of the scalpel, the bladder can then be pushed further downwards towards the pubes and away from the field of operation (fig. 1230).

The bladder is in danger of being opened in mistake for the peritoneum when, as the result of distension or displacement by an underlying tumour, it lies at an unexpectedly high level. Attention to the following points will ensure its recognition :

The bladder is fleshy in appearance while the peritoneum is shiny and membranous ; it bleeds freely when cut, and its brown muscular fibres can readily be recognised. When there is doubt as to its position the peritoneum should be incised at the upper end of the wound.

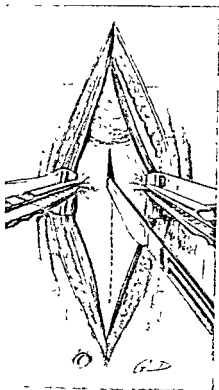


Fig. 1229.—RIGHT PARAMEDIAN INCISION. THE TWO RECTI MUSCLES ARE SEPARATED AND RETRACTED Laterally, EXPOSING THE PARIETAL PERITONEUM. THE BLADDER IS SEEN ATTACHED TO THE PERITONEUM AT THE LOWER END OF THE WOUND. A TRANSVERSE FOLD OF PERITONEUM IS PICKED UP WITH TWO PAIRS OF FORCEPS AND DIVIDED WITH A SCALPEL.

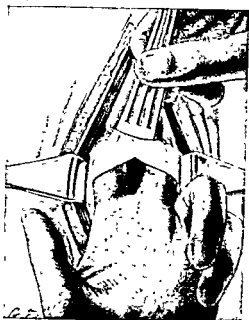


Fig. 1230.—STRIPPING THE BLADDER OFF THE PERITONEUM WITH THE HANDLE OF A SCALPEL.

A tumour such as an ovarian cyst may be adherent to the parietal peritoneum and cause much difficulty in differentiating between the two structures. The cyst wall is dense and fibrous, and the adherent peritoneum cannot be raised in a transverse fold prior to incising it. In such circumstances the peritoneum should be picked up at a higher level in the wound, and if necessary the incision should be extended upwards until the peritoneum above the adherent area is reached.

Preparing the Operation Area

The majority of abdomino-pelvic operations require manipulations deep in the pelvic cavity, and it is necessary that the sides of the wound be retracted and the edges protected from contamination. Septic material may be introduced from the skin, which can never be rendered absolutely sterile. Infection may also be conveyed upwards from the vagina or cervix when performing total hysterectomy, or from infected tubes or a pelvic abscess. Cancer cells may also be transplanted when

operation is performed for a malignant growth in the cervix, uterus or ovaries.

A towel to which a thin square of mackintosh is attached on its under-surface is folded over the entire thickness of the abdominal opening on each side. A Berkeley self-retaining retractor is then

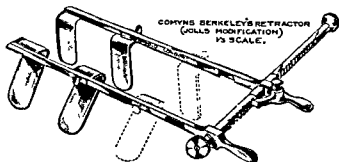


Fig. 1231.—SELF RETAINING ABDOMINAL RETRACTOR.

inserted and opened (fig. 1231). The flanges of the retractor curve slightly outwards and hold the towels against the under-surface of the peritoneum near the wound edge. The towels and mackintoshes are next folded in around each end of the opening and maintained in place,

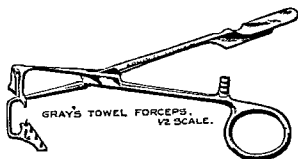


Fig. 1232.—GRAY TOWEL FORCEPS. THE TOWELS COVERING THE EDGES OF THE WOUND ARE INFOLDED AND HELD BY THE FORCEPS AT THE UPPER ANGLE OF THE INCISION.

at the upper end with a pair of Gray towel forceps (fig. 1232), and at the lower end with a silkworm-gut stitch which includes the edges of the aponeurosis and peritoneum.

The upper abdomen must be excluded from the pelvic cavity by packing with a medium-sized soft turkish towel wrung out in warm saline solution. One end of the towel is packed into the right iliac fossa, the other into the left, while the middle part lies across the centre of the abdomen. This towel is not intended to hold back coils of intestine forcibly. When the patient is placed in the Trendelenburg position the intestines fall by gravity into the upper abdomen if the anaesthesia is of the required depth. Coils still remaining in the pelvic cavity are gently lifted over the brim and allowed to slip upwards.

Bad anæsthesia creates difficulties for the surgeon and dangers for the patient. It is impossible to carry out any pelvic manipulation while coils of bowel are being forced down into the operation area. Forceful restraint of the intestines greatly adds to immediate shock and post-operative ileus, and increases the tendency to the formation of adhesions.

CLOSING THE ABDOMEN

The wound is the most vulnerable part of the operation field, being the most likely to become infected, and the same precautions should be taken in closing it as in making it. The skin edges are caught with Allis forceps and retracted, and the peritoneal edges are picked up with artery forceps. Beginning at the upper end, the peritoneal opening is sewn with a continuous double strand suture of No. 1 20-day catgut on a No. 1 trocar-pointed needle. After each two inches of the approximation a finger should be inserted along the deep surface of the suture line to make sure that there is no gap left and that no bowel or omentum has been caught up in the stitches. In cases of hysterectomy the peritoneum at the lower end of the wound must not be pulled up, as this will drag upon the suture line at the bottom of the pelvis where the anterior and posterior layers have been joined. It is also important to see that the peritoneum is completely closed and that the bladder has not been punctured. Should coils of intestine obtrude into the wound area as the result of inefficient anæsthesia or great bowel distension, there is very considerable risk of perforating the gut. A flat strip of metal or an ordinary table-spoon may be used to keep the intestines out of the way.

The edges of the rectus sheath may be united by :

- (1) Interrupted catgut sutures.
- (2) A continuous suture together with three or four reinforcing interrupted stitches.
- (3) A continuous catgut suture together with three or four reinforcing silkworm-gut stitches which include the aponeurosis, subcutaneous fat and skin.

The skin edges may be approximated with :

- (1) Interrupted silkworm-gut stitches.
- (2) Continuous silkworm-gut stitches.
- (3) An intradermic stitch, either of silkworm-gut or fine catgut.
- (4) Metal clips : (a) Michel (fig. 1235) ; (b) Kifa.

Metal clips hold the skin edges very accurately, and can be quickly applied and easily removed. Should the wound suppurate, a certain number can be removed, the remainder being left in place for a week or ten days. When metal clips are used a narrow strip of dressing should be fixed over them with four or five interrupted silkworm-gut stitches.

DRAINING THE PELVIC CAVITY

The indications for pelvic drainage are pelvic inflammations such as peritonitis, salpingo-oöphoritis, abscesses, or as a precautionary measure after the removal of inflamed appendages or after myomectomy where subsequent oozing of blood or effusion of serum is likely.

Route. Abdominal or vaginal.

Abdominal drainage is effected by means of a firm rubber tube about $\frac{1}{2}$ inch in diameter in which several small holes are cut in each side of the lower third. A gauze

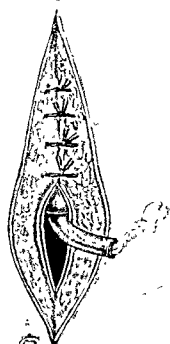


Fig. 1233.—THE UTERUS HAS BEEN VENTROFIXED BY INTERRUPTED CATGUT STITCHES. A DRAINAGE TUBE WITH A WICK OF GAUZE PASSES OVER THE TOP OF THE FUNDUS AND DOWN TO THE BOTTOM OF THE PELVIS.

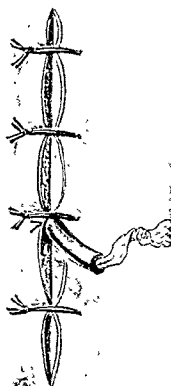


Fig. 1234.—THE EDGES OF THE WOUND AND SUBCUTANEOUS FAT ARE APPROXIMATED BY INTERRUPTED SUTURES OF SILKWORM-GUT. THE PELVIC PERITONEUM IS DRAINED BY A TUBE WHICH EMERGES ABOUT THE MIDDLE OF THE WOUND.

wick should be passed through it, protruding at both ends for one or two inches the wick at the upper end should be in contact with the dressings so that fluid from the pelvis may be soaked up by capillary attraction. The tube should reach the most dependent part of the pelvic cavity, or the bottom of a localised abscess if this is present. It may pass through the original abdominal wound or through a separate small incision. A silkworm-gut stitch passed through the tube and through both margins of the skin maintains it in position (fig. 1236).

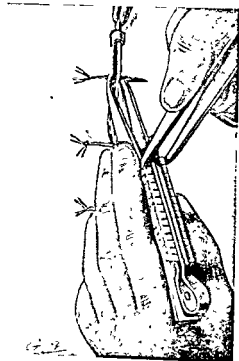


Fig. 1235.—APPROXIMATION OF THE SKIN WITH METAL CLIPS AFTER THE THREE TENSION SUTURES HAVE BEEN TIED.

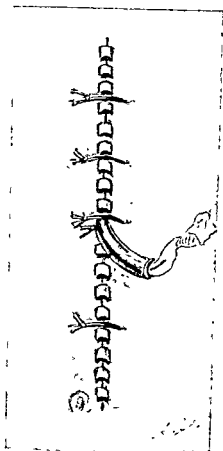


Fig. 1236.—THE SKIN EDGES ARE APPROXIMATED WITH METAL CLIPS, AND THE DRAINAGE-TUBE IS SECURED BY A STITCH OF SILKWORM-GUT.

Drainage is sometimes advisable after salpingectomy and myomectomy when these operations are followed by a ventro-fixation of the uterus. In such cases the upper end of the tube emerges above the uterine fundus (fig. 1233) and therefore high in the wound (fig. 1234).

Removal of the tube. When suppuration is not present the fixation stitch should be cut at the end of 24 hours, and the tube withdrawn for 2 inches and a large safety-pin passed through the tube to prevent it from slipping back into the abdomen. The wick of gauze should then be removed, and the tube and depths of the cavity wiped dry by inserting strips of gauze. The tube should be removed in 48 hours, but in the case of suppuration it may be required for several days.

Drainage via the vagina may be effected by the operation of colpotomy, or through the open upper end of the vagina after hysterectomy. In the latter case a tube is not always necessary. After radical hysterectomy for carcinoma of the cervix, the vagina is very short and the bladder falls down over the opening. When there is oozing which cannot be controlled by ligatures this area may be packed by a strip of gauze passed through a rubber tube, $\frac{1}{2}$ inch in diameter and 3 inches long, which is stitched into the vaginal opening with plain catgut. This packing will arrest hæmorrhage and must be removed in 36 hours.

CHAPTER III

VULVAL AND VAGINAL OPERATIONS

EXCISION OF THE VULVA

Indications. Carcinoma, tuberculosis, leucoplakic vulvitis, elephantiasis, hypertrophy, and intractable pruritus.

Procedure. An incision is made around the vaginal entrance and in front of the urethra (fig. 1237). A second incision beginning above the glans clitoridis passes around the vulva so as to include the labium majus on each side and the fourchette posteriorly. In cases of carcinoma a wide margin of uninvaded skin must be left between the growth and the cut edge.

The tissues lying between the two incisions down to the deep fascia are now dissected free and removed.

The cut edges are united all around the vaginal entrance by a series of interrupted catgut stitches (fig. 1240). The first two stitches are inserted on each side uniting the skin to the cut edge surrounding the urethra (fig. 1239), and the skin edges in front of the urethra are brought together from side to side. Should there be difficulty in bringing the outer skin edge into contact with that around the vaginal entrance, it should be undermined for a variable distance, usually about 1 inch; there is, however, seldom any great difficulty in approximating the edges.

Dressings and After-Treatment. The wound should be smeared with bismuth ointment containing 5 per cent chloretone and dressed with dry gauze, wool and a T-bandage.

Morphia, $\frac{1}{4}$ gr. twice or thrice daily for two days after the operation, may be necessary for the relief of pain.

The patient should be allowed to get up, or at least sit up, to empty the bladder, but catheterisation will in all probability be required. If the growth has been septic, suppuration in the wound is probable, and a catheter should therefore be stitched in position for a few days.

Removal of Inguinal Glands. The glands in both groins should always be removed when the vulva is excised for carcinoma. The wound is particularly liable to suppurate if the growth is foul and infected, and in such cases removal of the glands should be postponed

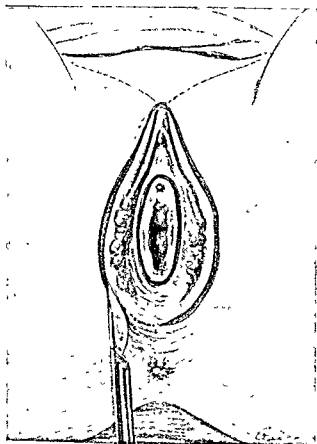


Fig. 1237.—EXCISION OF THE VULVA. HERE THE VULVA IS THE SEAT OF A CARCINOMATOUS GROWTH. AN INCISION HAS BEEN MADE AROUND THE VAGINAL ENTRANCE AND ABOVE THE URETHRA. A SECOND INCISION IS MADE, BEGINNING OVER THE UPPER PART OF THE CLITORIS IN FRONT, PASSING DOWNWARDS ALONG THE GREATER LABIUM ON EACH SIDE, AND MEETING BEHIND THE FOURCHETTE IN THE MID LINE POSTERIORLY. THE LINE OF INCISION FOR THE REMOVAL OF THE INGUINAL GLANDS ON EACH SIDE IS INDICATED.

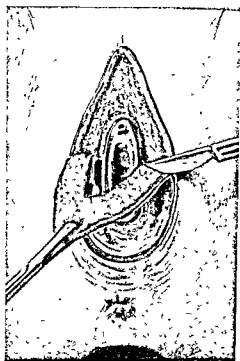


Fig. 1238.—EXCISION OF THE VULVA. THE SKIN AND SUBCUTANEOUS TISSUES DOWN TO THE DEEP FASCIA AND BETWEEN THE TWO INCISIONS PREVIOUSLY MADE ARE DISSECTED FREE AND REMOVED.

for ten to fourteen days. If the growth is very small and there is no evidence of suppuration, the glands can be removed at the same time as the vulva.

An incision is made parallel with and about half an inch above Poupart's ligament. The medial end of each incision should continue downwards into the upper end of the one made for the removal of the vulva (fig. 1241). The edges of the wound are now retracted on each side. All the connective tissue above and below Poupart's ligament down to the deep fascia and including the horizontal group of inguinal

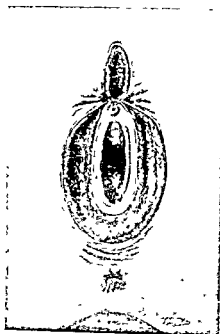


Fig. 1239.—EXCISION OF THE VULVA. THE FIRST TWO STITCHES ARE TIED.

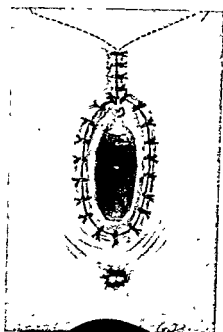


Fig. 1240.—EXCISION OF THE VULVA. THE CUT EDGES ARE UNITED WITH INTERRUPTED CATGUT STITCHES ALL AROUND THE VAGINAL ENTRANCE AND FROM SIDE TO SIDE IN FRONT OF THE URETHRA.

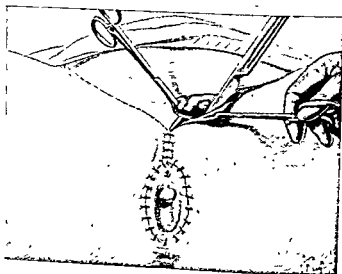


Fig. 1241.—EXCISION OF VULVA AND INGUINAL GLANDS. THE GLANDS AND CONNECTIVE TISSUE IN THE LEFT GROIN ARE NOW DISSECTED FREE AND REMOVED. THE INGUINAL INCISIONS ON BOTH SIDES ARE CARRIED DOWN SO AS TO JOIN THE UPPER PART OF THE INCISION MADE FOR THE REMOVAL OF THE VULVA.

glands is stripped off by sharp dissection assisted by swab pressure. Dissection should begin near the anterior superior iliac spine and be continued medially and downwards to the symphysis pubis; in this way all the lymphatic vessels from the vulva are removed together with the glands. A small drainage-tube is inserted and the wound is closed by interrupted silkworm-gut stitches.

The same procedure is now carried out on the opposite side.

Dressings and After-Treatment. The wounds are dressed with gauze which is held in place by a spica bandage. The drainage-tubes are removed within 24 hours. Daily inspection is made, and should any sign of suppuration be observed, hot fomentations should be applied immediately and the stitches in the affected part removed.

OPERATIONS ON BARTHOLIN'S GLAND

(A) Drainage of a Bartholin abscess.

(B) Excision of a chronically suppurating Bartholin gland.

Drainage of a Bartholin abscess. Complete excision of Bartholin's gland has been advocated in cases of acute suppuration. It is, however, much safer to drain the abscess in the first instance and then excise the gland at a later date. Drainage alone never produces a cure. The gland being of a compound racemose type, other acini become infected and recurrent abscesses or continuous discharge will result.

Procedure. A free incision is made over the most prominent part of the swelling in the long axis of the labium majus, pus is evacuated, and the cavity is packed with gauze saturated with glycerine.

After-Treatment. Hot fomentations are applied immediately, and the cavity is repacked daily with gauze soaked in glycerine until all acute signs and symptoms have subsided.

Excision of a chronically suppurating Bartholin gland. The indurated gland and surrounding tissues are defined by palpation. A double incision is made in the long axis of the labium majus over the full diameter of the indurated zone so as to include the sinus and a narrow ellipse of skin.

The skin edges are retracted and the outlined portion of skin is

held with forceps. Traction is made on these while the indurated tissues are dissected free.

Oozing is arrested as far as possible, and the wound is dried and thoroughly swabbed with tincture of iodine. A small drainage-tube is inserted into the depths of the cavity which is then partly closed with catgut stitches. The skin edges may be sewn with catgut, or preferably with one or two stitches of silkworm-gut.

REMOVAL OF A BARTHOLIN CYST

The cyst is held between the thumb and fingers of the left hand and the tense skin over the most prominent part of it is incised longitudinally (fig. 1242). The edges are retracted and sharp dissection is carried out so as to isolate the cyst, the whole of which must be removed (figs. 1243 and 1244). As the cyst is usually adherent to the labium minus on the inner side, it is advisable to dissect the outer side



Fig. 1242.—REMOVAL OF A BARTHOLIN CYST. THE INCISION. THE SWELLING IS PICKED UP BETWEEN THE THUMB AND FINGER SO AS TO ELEVATE IT AND TO TIGHTEN THE SKIN OVER ITS SURFACE, THE LINE OF INCISION IS INDICATED.

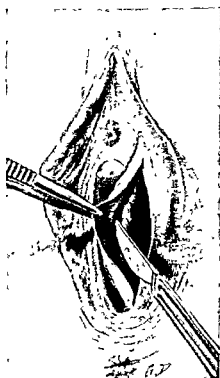


Fig. 1243.—REMOVAL OF A BARTHOLIN CYST. THE MEDIAL EDGE OF THE INCISION IS LIFTED UP AND UNDERCUT WITH A SCALPEL.

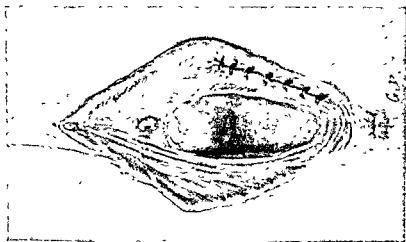


Fig. 1246.—REMOVAL OF A BARTHOLIN CYST. THE OPERATION IS COMPLETED BY SUTURING THE WOUND IN THE SKIN OF THE VULVA WITH A CONTINUOUS CATGUT SUTURE.

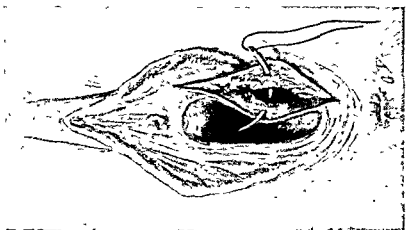


Fig. 1245.—REMOVAL OF A BARTHOLIN CYST. THE CYST HAVING BEEN REMOVED, THE RESULTING CAVITY IS OBLITERATED WITH INTERRUPTED CATGUT STITCHES.

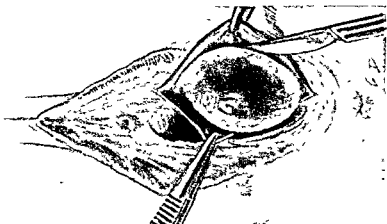


Fig. 1244.—REMOVAL OF A BARTHOLIN CYST. THE EDGES ARE RETRACTED AND THE CYST IS REMOVED BY DISSECTION.

and the deep aspect of the cyst first, leaving the freeing of the inner side until last.

The cavity is then obliterated from the bottom upwards with interrupted stitches of fine catgut (figs. 1245 and 1246).

CARCINOMA OF A BARTHOLIN GLAND

The operation is performed in two stages :

- (1) Removal of the growth.
- (2) Removal of the inguinal glands on both sides.

Procedure. Stage 1. The limits of the growth are defined as far as possible by palpation of the indurated zone, and an incision is made around it, passing wide of the involved area of the skin. The wound edges are retracted with Allis forceps, elevated, and dissected free from the underlying tissues.

The growth is held with two pairs of Allis forceps, pulled upwards and then cut away from the surrounding tissues by sharp dissection. The excision may involve part of the vaginal wall, the perineal body, or even the sphincter ani, but a wide dissection must be made, regardless of the tissues severed.

The sides of the wound are approximated with catgut stitches from the bottom upwards. The skin and vaginal margins should be sutured if possible, but undercutting of these structures may be necessary in order to effect this. Where approximation proves impossible the wound is left to heal by granulation. A drainage-tube is inserted for 24 hours.

Stage 2. Removal of the inguinal glands may be carried out immediately after the growth has been removed. But if the growth has ulcerated through the skin and is septic and foul, this dissection must be delayed until the wound of the first operation has completely healed or is clean and granulating.

The glands in each groin are now removed by dissection.

Dressings and After-Treatment. Where the skin edges have been sutured, dry dressings are used and subsequent treatment carried out on the same lines as for excision of the vulva. The wound is swabbed with dettol solution (1 in 20) twice daily and after every evacuation.

Should suppuration occur, the skin stitches should be removed and hot fomentations applied 4-hourly during the day, and gauze dressings soaked in glycerine during the night. When an open wound is left to granulate after operation it is dressed 4-hourly with gauze soaked in glycerine. The patient is kept in bed until healthy granulations are formed and healing is well established.

WARTS OF THE VULVA

Syphilitic condylomata generally yield to anti-syphilitic treatment and local dusting with zinc oxide powder. A gonococcal wart may attain a large size, resembling the head of a cauliflower, or there may be numerous smaller papillomata scattered over the vulva, and sometimes on the vaginal wall and over the cervix.

Procedure. The skin of the vulva, mons, inner sides of the thighs, and the vagina are painted with 3 per cent picric acid in rectified spirit, the warts also being thoroughly saturated with the same solution. The warty masses are then scraped off with a sharp curette; they come away easily, the base of attachment extending in depth only to the cutis vera. Search must be made over the entire vulva, vagina and cervix for similar papillomata. Free oozing of blood will follow the scraping, but this can be arrested by packing with dry cotton wool. The surfaces are then again painted with 3 per cent picric acid.

Dressings and After-Treatment. The vagina is lightly packed with dry gauze, the raw surface is covered with dry wool, and pressure is applied by a T-bandage. The vaginal pack is removed after 12 hours. The vulva is swabbed with 1 in 20 lysol solution or 2½ per cent dettol, and dry dressings are applied after each evacuation of the bowels. Healing is rapid, and the patient is not usually kept in bed for longer than a week.

CLITORIDECTOMY

Indications. Clitoridectomy may be required for either carcinoma or hypertrophy of the organ.

(a) *Carcinoma.* The clitoris is a common site for the development of carcinoma. The growth invades the lesser and greater labia at an early stage. The radical operation for its removal is similar to that described under Excision of the Vulva, this being followed by removal of the glands in both groins.

The skin incisions must be made wide of the affected area and the whole clitoris down to the attachment of its crura to the pubic rami must be excised.

(b) *Hypertrophy.* Operation may be indicated when the enlargement of the clitoris is sufficient to cause dyspareunia.

Procedure. A curved incision is made around the base of the enlarged clitoris. The lateral skin edges are retracted with Allis forceps, the clitoris is drawn upwards and its base of attachment to the pubic symphysis is divided with a scalpel. Free bleeding will occur from the dorsal vessels of the clitoris in the mid-line, and from the corpora cavernosa which must be separately underrun with catgut and tied. The two edges of the incision are now approximated with interrupted silkworm-gut stitches which pass deep to the raw surface.

URETHRAL CARUNCLE

Procedure. A bladder sound is passed, and the urethra is dilated up to 12 Hegar. The caruncle is gently pulled downwards and a suture is passed from side to side through the floor of the urethra, $\frac{1}{4}$ inch above the caruncle. This suture is used to bring down the urethral mucosa after the caruncle has been excised.

The caruncle is picked up with forceps, and an incision is made round its base, leaving a narrow but definite margin of mucous membrane between the cut edge and the base, which is now undercut to a depth of at least $\frac{1}{8}$ inch. The free bleeding which will result can be arrested to some extent by hot compresses.

Traction is made on the stitch through the urethral floor, bringing the upper cut edge into view. Three or four interrupted catgut stitches, which approximate the edges and control oozing, are then inserted from above downwards, and a bladder sound is passed to ensure patency of the urethral lumen.

Dressings and After-Treatment An antiseptic pad is applied; whenever this is removed, and also after all evacuations, the vulva is swabbed with lysol solution (1 in 20), and the suture line is smeared with 5 per cent chlorethane ointment to prevent contamination and to relieve pain. Morphia, $\frac{1}{2}$ gr., will be required twice or thrice daily for the first 48 hours. Catheterisation may be necessary, but every effort should be made to encourage the patient to empty the bladder naturally.

Comments Urethral caruncles have a marked tendency to recur. This is not likely, however, if the base of the growth is excised deeply and widely. It is sometimes difficult to pass the stitches and ensure exact approximation of the upper and lower cut edges, owing to the free oozing which occurs.

AN ALTERNATIVE METHOD

This is similar to the technique just described, except that a diathermy knife is used in place of a scalpel. The advantage of this method is that oozing, which is always very free and troublesome, is entirely prevented, the tissues being coagulated as they are cut.

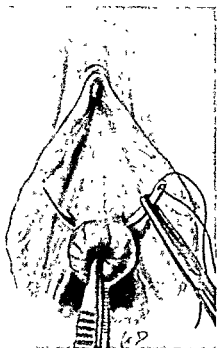


Fig. 1247.—OPERATION FOR PROLAPSE OF THE URETHRA. TRANSFIXION OF THE URETHRA ABOVE THE PROLAPSED PORTION WITH A NEEDLE THREADED WITH CATGUT.



Fig. 1248.—OPERATION FOR PROLAPSE OF THE URETHRA. THE PROLAPSED PORTION OF THE MUCOUS MEMBRANE BELOW THE TRANSFIXION STITCH IS EXCISED TRANSVERSELY.

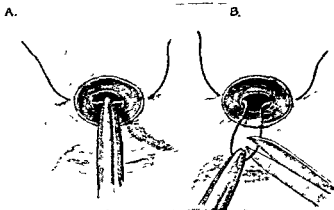


Fig. 1249.—OPERATION FOR PROLAPSE OF THE URETHRA. A. THE TRANSFIXION STITCH IS GRASPED WHERE IT CROSSES THE LUMEN OF THE URETHRA. B. THE LOOP IS PULLED OUT AND DIVIDED.

PROLAPSE OF THE URETHRA

Procedure. Tissue forceps are applied to both the anterior and the posterior portions of the prolapsed mucosa, and traction is made so that the mucosa is brought down to its full extent.

A trocar-pointed needle threaded with No. 2 20-day chromic catgut is passed from side to side through the urethra above the prolapsed portion, after which the extruded mucosa below the transfixion stitch is cut away (figs. 1247 and 1248).

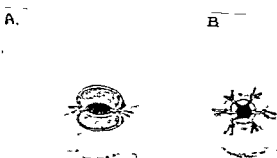


Fig 1250.—OPERATION FOR PROLAPSE OF THE URETHRA. A. EACH HALF OF THE TRANSFIXION STITCH IS TIED, APPROXIMATING THE CUT EDGES ON EACH SIDE OF THE URETHRA. B. FOUR OTHER STITCHES ARE PASSED, UNITING THE CUT EDGES OF THE URETHRAL MUCOUS MEMBRANE TO THE SKIN OF THE VESTIBULE ALL AROUND THE URETHRA.

The transfixion stitch is seized as it crosses the urethral canal and pulled out in a long loop (fig. 1249). This is divided, converting each half into a separate stitch which is then tied and held. A series of fine interrupted sutures are now inserted so as to unite the cut edges of the urethral mucous membrane with the skin of the vestibule (fig. 1250). Bleeding is free until the stitches are tied. A bladder sound is passed to ensure that there is no constriction of the lumen.

Comments. Prolapsed mucosa is a very rare condition; when it occurs to any marked extent, the operation described above is the only satisfactory treatment.

Stricture is not likely to follow unless too wide an area of surrounding skin has been removed, or unless suppuration has interfered with primary union; subsequent stricture may be dealt with by urethral dilatation, or by division of the constriction and suture of the raw area in such a manner as to increase the circumference of the opening.

SUB-URETHRAL ABSCESS

Procedure. An Auvard speculum is passed into the vagina to expose the swelling, and a bladder sound is inserted into the bladder to define the position of the urethra and bladder floor and their exact relationship to the swelling. The abscess is incised antero-posteriorly for its full length, giving free vent to pus. The cavity is then emptied by gentle pressure, after which it is swabbed with tincture of iodine and packed with gauze soaked in glycerine.

Dressings and After-Treatment. The vaginal entrance is packed with gauze and a pad is applied to the vulva; the packing is removed in 24 hours, and renewed daily for three or four days.

OPERATIONS ON THE VAGINA

ANTERIOR COLPORRHAPHY

Indications. This operation is indicated for the cure of cystocele. The procedure here described is a modification of the buttress operation of Blair Bell.

Procedure. An Auvard speculum is inserted into the vagina, and the cervix is drawn downwards with a vulsellum so as to put the anterior vaginal wall on the stretch.

A transverse incision about $\frac{1}{2}$ inch long is made through the vaginal wall close to its junction with the anterior aspect of the cervix (fig. 1251). The upper edge of the incision is picked up with forceps and the intervesico-vaginal plane is identified. The points of a pair of scissors are gently thrust upwards along this plane, the blades being opened frequently during the process so as to separate the bladder from the vagina (fig. 1252). The separation is extended to within $\frac{1}{4}$ inch of the urethral meatus. When there is much sacculation of the anterior wall, large uterine forceps may be inserted and opened, thus effecting a wider lateral stripping of the vagina from the bladder.

This separated anterior vaginal wall is now divided with scissors in the mid-line to a point within $\frac{1}{4}$ inch of the urethral meatus (fig. 1253). The edges of these flaps are picked up with two pairs of Allis forceps, one at the middle and the other at the upper end. Each flap is put on the stretch and the bladder is further stripped away by

swab pressure. This separation is usually accomplished quite easily, but occasionally, when the cystocele is large and of long standing, small fibrous adhesions may be encountered. These are divided and the plane of cleavage is further enlarged by blunt dissection with the scissors (figs. 1254 and 1255).

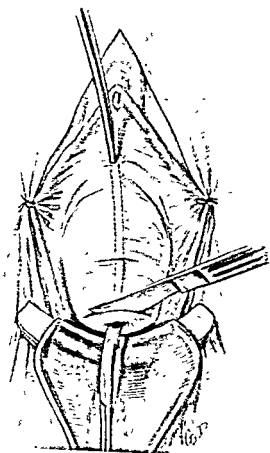


Fig 1251—ANTERIOR COLPORRHAPHY. THE LABIUM MINUS ON EACH SIDE IS RETRACTED AND HELD OUT OF THE WAY WITH SUTURES. THE CERVIX IS PULLED DOWNWARDS AND STEADIED WITH A VULSELLUM, AND A SOUND IS PASSED TO THE LIMIT OF THE BLADDER AT THE VAGINO-CERVICAL JUNCTION. A TRANSVERSE INCISION IS BEING MADE AT THE VAGINO-CERVICAL JUNCTION.

The part of the bladder now exposed will be seen to be covered with a firm fibrous sheet—the pubo-cervical fascia, which may be so thin as to be deficient in the mid-line.

The lowest limit of the bladder may be identified by passing a sound through the urethra. At this level the pubo-cervical fascia is attached to the front of the cervix. This attachment should be divided, and by swab pressure the bladder stripped off the front of the

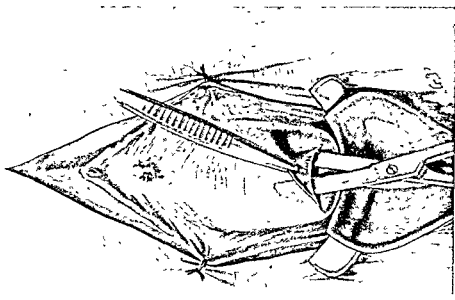


Fig. 1252.—ANTERIOR COLPORRHAPHY. SEPARATION OF THE VAGINA FROM THE BLADDER. THE UPPER EDGE OF THE WOUND IS RETRACTED WITH FORCEPS AND THE SCISSORS ARE INTRODUCED THROUGH THE INCISION, THUS SEPARATING THE ANTERIOR VAGINAL WALL FROM THE BLADDER.

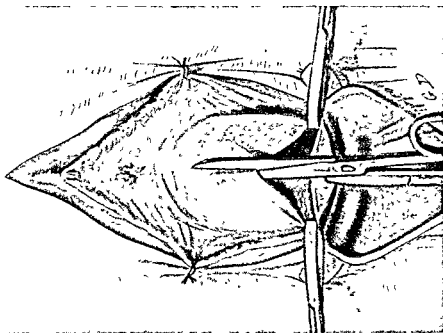


Fig. 1253.—ANTERIOR COLPORRHAPHY. THE ANTERIOR VAGINAL WALL WHICH HAS BEEN SEPARATED FROM THE BLADDER IS NOW INCISED LONGITUDINALLY.

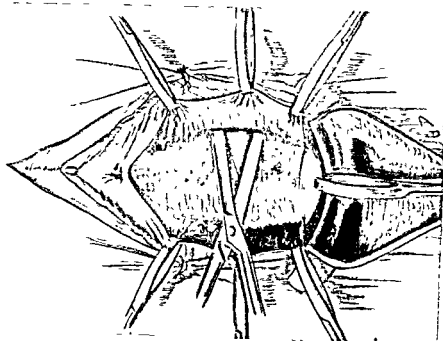


Fig. 125.—ANTERIOR COLPORRHAPHY. FURTHER SEPARATION OF THE BLADDER FROM THE VAGINAL WALL ON EACH SIDE IS MADE BY INSERTING THE POINTS OF THE SCISSORS BETWEEN THESE TWO LAYERS, AND OPENING THE BLADDER WIDELY.

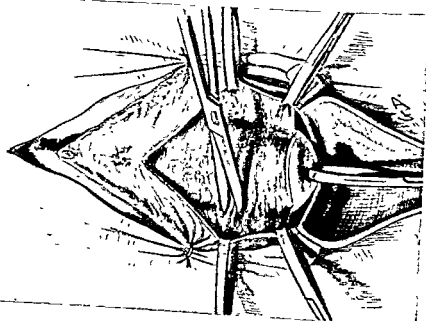


Fig. 124.—ANTERIOR COLPORRHAPHY. THE ANTERIOR VAGINAL WALL HAS BEEN DIVIDED AND THE TWO LATERAL FLAPS ARE RETRACTED. THE FIBROUS BANDS BETWEEN THE ANTERIOR VAGINAL WALL AND THE ANATOMOCROTIS COVERING THE BLADDER ARE DIVIDED WITH SCISSORS.

cervix and lower uterine segment and pushed upwards (fig. 1256). A few snips with the scissors may be required to facilitate separation on each side of the cervix.

The pubo-cervical fascia is next pleated by picking up small portions of it about $\frac{1}{2}$ inch lateral to the middle line on each side with a needle threaded with plain catgut (fig. 1257). Usually three stitches

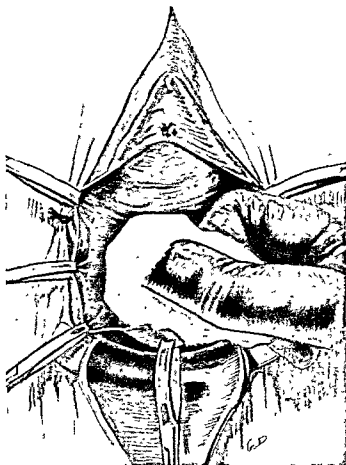


Fig. 1256.—ANTERIOR COLPORRHAPHY. THE VAGINAL FLAPS HAVING BEEN FREED AS FAR AS POSSIBLE, THE BLADDER IS NOW STRIPPED OFF THE ANTERIOR ASPECT OF THE CERVIX AND LOWER UTERINE SEGMENT AND PUSHED UPWARDS BY SWAB PRESSURE.

are inserted, the first about 1 inch from the meatus. As these pleats are approximated the fascia is infolded in the central line and tightened laterally. The last stitch includes a bite of the anterior part of the lower segment of the uterus after the sacculated part of the bladder has been pushed upwards. This gives the fascia a new and shorter attachment to the front of the lower uterine segment, affording two advantages: (1) a firm strong floor for the bladder, preventing it from sacculating

downwards; and (2) a gentle forward traction on the uterus, tending to maintain it in an anteverted position.

The two flaps of separated vaginal wall are now brought together so as to form a ridge or buttress by passing three or four mattress

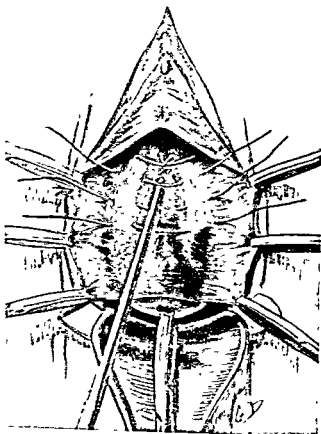


Fig. 1257—ANTERIOR COLPORRHAPHY. THE BLADDER HAVING BEEN SEPARATED FROM THE ANTERIOR ASPECT OF THE CERVIX AND LOWER UTERINE SEGMENT IS PUSHED UPWARDS. PLEATING OF THE PUBO-CERVICAL (SUB-VESICAL) FASCIA WITH INTERRUPTED CATGUT STITCHES IS SHOWN. THE TWO LOWER STITCHES PICK UP SMALL PORTIONS OF THE ANTERIOR ASPECT OF THE LOWER UTERINE SEGMENT IN THE CENTRAL LINE. THE ROD IS PUSHING UP THE SACCOLATED PORTION OF THE BLADDER WHICH HAS PREVIOUSLY BEEN SEPARATED FROM THE FRONT OF THE UTERUS AND CERVIX.

sutures of catgut. The last two stitches pick up a small portion of the front of the cervix (figs. 1258 and 1259).

The redundant portions of the flaps are removed with scissors, the line of section being about $\frac{1}{4}$ inch from the mattress sutures. The cut edges are now united by a continuous stitch of plain catgut (figs. 1260 and 1261).

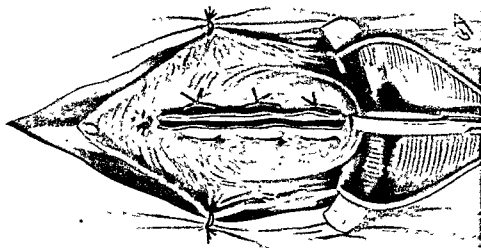


Fig. 1250.—ANTERIOR COLPORRHAPHY. MATTRESS SUTURES TIED, BRINGING THE VAGINAL FLAPS TOGETHER SO AS TO FORM A KEEL OR BUTTRESS.

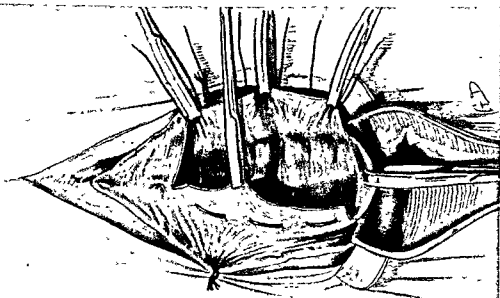


Fig. 1253.—ANTERIOR COLPORRHAPHY. REDUNDANT PORTIONS OF THE VAGINAL FLAPS HAVE BEEN TRIMMED AWAY. THREE MATTRESS STITCHES HAVE BEEN INTRODUCED, THE LOWER TWO OF WHICH PICK UP A SMALL PORTION OF THE ANTERIOR UTERINE WALL IN THE MID LINE.

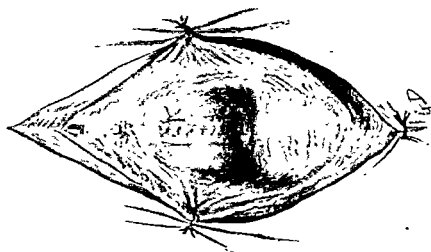


Fig. 1201.—ANTERIOR COLPORRHAPHY. APPEARANCE OF THE PART AFTER THE OPERATION IN COMBINED, COLIO-EPIDIDYMIC ALSO IN OFTEN REQUIRED.

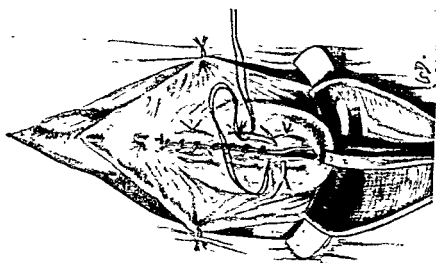


Fig. 1202.—ANTERIOR COLPORRHAPHY. THE OPERATION IN COMBINED BY APPROXIMATING THE EDGES OF THE VAGINAL WALL WITH A CONTINUOUS SUTURE.

The bladder may be punctured during the dissection, especially in long-standing cases of cystocele in which there is much fibrosis and many adhesions of the vaginal wall to the sub-vesical fascia. In making the separation the points of the scissors should be directed against the vaginal flap and away from the bladder. The risk of injury is further minimised by passing a catheter to ensure that the bladder is empty immediately prior to operation.

Dressings and After-Treatment. The vagina is swabbed with antiseptic, and then dried and lightly packed with gauze soaked in sterile liquid paraffin. This is removed in twelve hours. Gentle irrigation with eusol solution 10 per cent is carried out on the second day to remove any clots or discharge, and pure eusol, 2 drachms, is instilled daily for ten days. A sterile douche nozzle is passed into the vagina daily and moved from side to side to separate the walls and prevent adherence of the anterior and posterior suture lines.

In the majority of cases the bladder will require catheterisation at intervals of twelve hours; normal bladder function is usually restored between the third and tenth day. The catheter when passed should be directed almost vertically upwards.

COLPO-PERINEORRHAPHY

Indications. This operation is performed for the repair of laceration of the perineum, rupture or attenuation of the levatores ani muscles, and rectocele or prolapse of the posterior vaginal wall (fig. 1262). It is always a part of the operation for prolapse.

Procedure. A bite of tissues on each side of the vaginal entrance at the level of the posterior ends of the labia minora is held with forceps. These are retracted laterally, throwing the skin of the perineum into a sharp transverse fold, which is excised from side to side with a scalpel (fig. 1263), leaving a narrow raw area between the vaginal mucosa anteriorly and the skin of the perineum posteriorly.

The posterior cut edge of the vagina is lifted upwards in the mid-line with forceps and pulled forwards, and the vagina separated by sharp dissection from the connective tissue of the perineal body (fig. 1264). Two fingers of the left hand, covered with a swab, are passed into the vagina, the cut edge of which is then rotated between these two fingers and the thumb so as to facilitate the stripping of its posterior surface (fig. 1265). The rectum is then stripped clear with gauze pressure and

pushed backwards. This dissection should extend almost as high as the cervix, and be widened laterally by stretching with the index fingers. This further peels off the rectum and exposes the antero-medial edges of the levatores ani muscles.

A V-shaped portion of the denuded vaginal flap must be removed to restore the vagina to its normal dimensions (fig. 1266). The segment to be removed is outlined with three pairs of forceps, one pair being

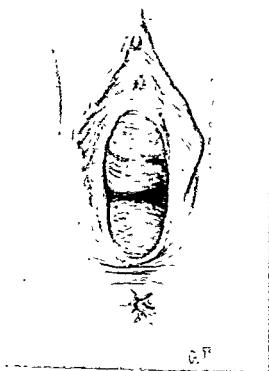


Fig. 1266.—CYSTOCELE AND RECTOCELE.

placed on the vaginal wall in the mid-line near the cervix; the other two, which are the original forceps attached to the vaginal entrance, demarcate the base of the flap. This triangular portion of the vagina is then excised.

The cut edges of the posterior vaginal wall are sutured together from above downwards with plain catgut to within 1 inch of the lower end.

The edges of the levatores ani muscles are now identified and deep sutures of catgut are inserted so as to bring them together in front of

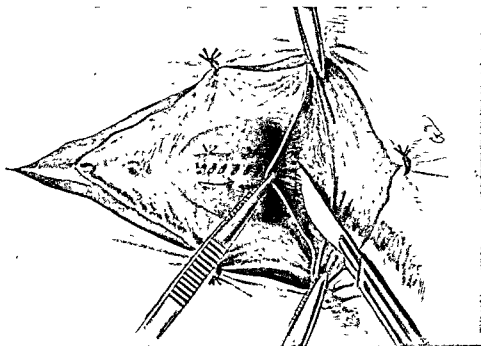


Fig. 1261.—Colpo perineorrhaphy. Reflection of the flap of the posterior vaginal wall.

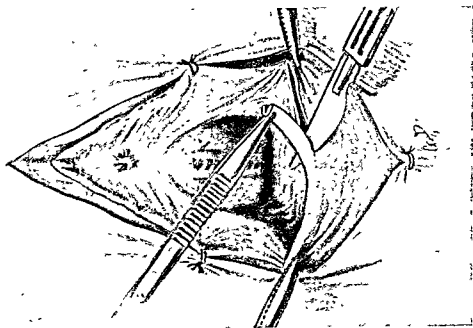


Fig. 1263.—Colpo perineorrhaphy. Delineation of a transverse fold of the skin of the perineum, the edge of which is being excised with the scalpel.

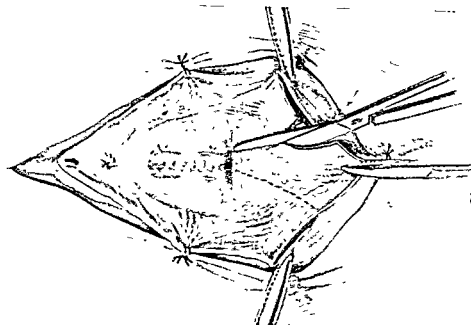


Fig 1264.—COLLO-LEVINERMANSHV. THE REMOVAL OF A V-SHAPED
SPUR OF THE DENuded FLAP OF THE POSTERIOR VAGINAL WALL.
THE UNITED STATES ARMY.

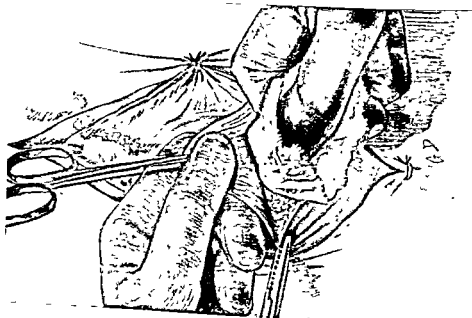


Fig 1265.—COLLO-LEVINERMANSHV. THE ANTERIOR VAGINAL WALL
IS SEPARATED FROM THE RECTUM BY GAZER DISSECTION.

the rectum (figs. 1267 and 1268). When the suturing is complete, the taut edge of each muscle can be felt as a ridge, bulging the infero-lateral vaginal walls about 1 inch above the entrance.

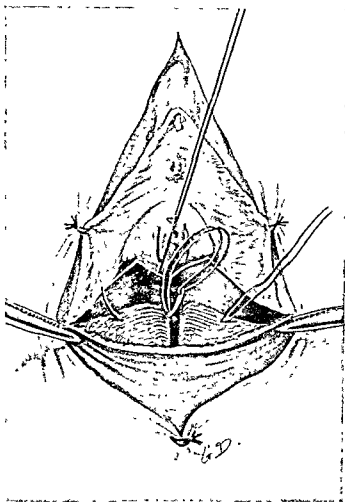


Fig 1267.—COLPO PERINEORRHAPHY. THE FLAPS OF THE POSTERIOR VAGINAL WALL HAVE BEEN PARTIALLY SUTURED IN THE MIDDLE LINE. THE SUTURE IS BEING PASSED FOR THE APPROXIMATION OF THE LEVATORES ANI MUSCLES.

The suture of the posterior vaginal wall is then completed (figs. 1269 and 1270).

The connective tissues of the perineum on each side are now sewn together, thus restoring the perineal body. The operation is completed by suturing the skin longitudinally with interrupted stitches of silk-worm-gut or a continuous stitch of catgut.

ALTERNATIVE TECHNIQUE (Fothergill's method)

In this operation repair of the posterior wall of the vagina is effected from above, before the perineum is reconstructed. A V-shaped

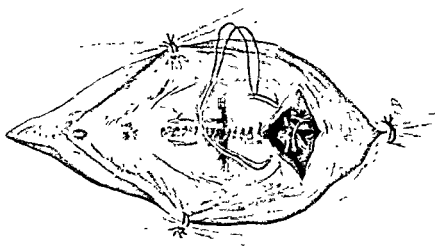


Fig. 1200.—CULTO LERIKORHAIUS. THESE TURE OF THE ANTERIOR VAGINAL WALL WHICH WAS LEFT UNFINISHED IS NOW BEING COMPLETED; THE STITCHES LINE UP A SMALL PORTION OF THE UNDERLYING UNITED EDGES OF THE LEVATOR ANI MUSCLES TO COLLECTED IN DEAD SPACES. INTERRUPTED STITCHES MAY BE USED.

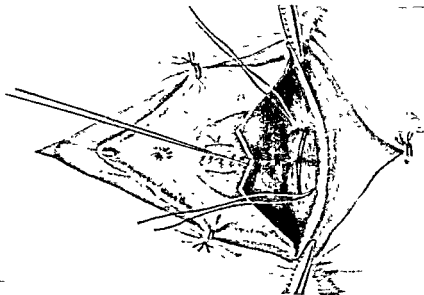


Fig. 1201.—CULTO LERIKORHAIUS. APPROXIMATION OF THE LEVATOR ANI MUSCLES. THE SUTURE ABOUT TO BE TIED.

incision with the apex upwards and close to the cervix is outlined on the posterior vaginal wall with tissue forceps. The flap of the vaginal wall is dissected free for a short distance and the raw triangle so left is sutured from above downwards with catgut. The forceps are moved lower down the vagina and the process of excision and suture is

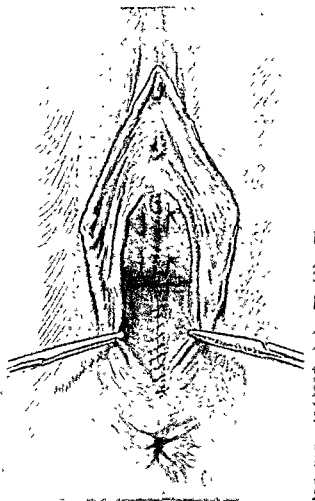


Fig. 1270 —COLPO PERINEORRHAPHY. THE OPERATION IS COMPLETED BY SEWING THE MARGINS OF THE SKIN OVER THE PERINEAL BODY.

repeated until the perineal skin is reached. At this point the base of the flap is cut free. After suturing the gap, the newly formed vaginal orifice should be of normal size.

The skin close to the vaginal wall is then incised and undercut laterally for a short distance. Dissection is deepened through the connective tissue until the retracted edges of the levatores ani muscles are exposed. These are brought together with interrupted stitches of catgut, and the more superficial tissues are sutured before finally closing the skin.

OPERATION FOR COMPLETE RUPTURE OF THE PERINEUM

The operation for complete rupture is in many respects similar to posterior colpo-perineorrhaphy. Two additional steps are necessary: (1) Restoration of the anterior rectal wall, and (2) repair of the sphincter ani (fig. 1271).

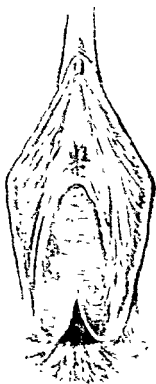


Fig. 1271.—COMPLETE LACERATION OF THE PERINEUM.

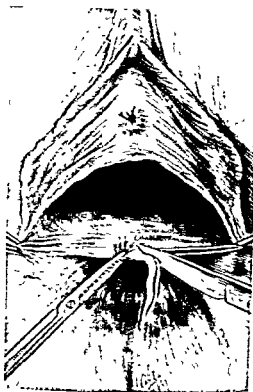


Fig. 1272.—OPERATION FOR COMPLETE RUPTURE OF THE PERINEUM. THE POSTERIOR MARGIN OF THE VAGINAL WALL HAVING BEEN RETRACTED Laterally, THE EDGE OF THE RECTO-VAGINAL SEPTUM IS THUS RENDERED TIGHT AND REMOVED WITH A SCALPEL.

Procedure. Two pairs of forceps are attached to the lower edge of the vagina just internal to the posterior extremities of the labia minora. When these are retracted the thin recto-vaginal septum is stretched and its edge removed with the scalpel, exposing the line of demarcation between the rectal and vaginal mucous membranes (fig. 1272).

The vaginal mucosa is picked up with two pairs of tissue forceps at the central part of its lower edge. Two other pairs are similarly

placed on the anterior rectal wall. The intervening tissues are incised transversely between the rectum and the vagina, and by swab pressure the vaginal flap is freed upwards towards the cervix, and outwards so as to expose the edges of the levatores ani muscles (fig. 1273). An incision is carried downwards and backwards on each side from the extremity of the original transverse division of the perineum for a distance of about $\frac{3}{4}$ inch, and the ends of the sphincter ani are exposed by dissection (fig. 1274).

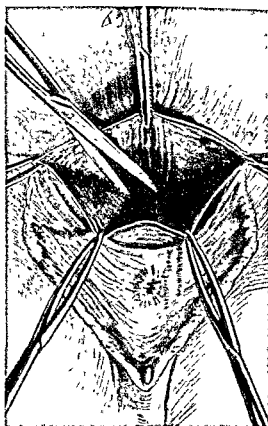


Fig. 1273.—Operation for complete rupture of the perineum. The lower edge of the anterior rectal wall is pulled downwards and backwards and separated from the vagina, the edge of which is pulled upwards.

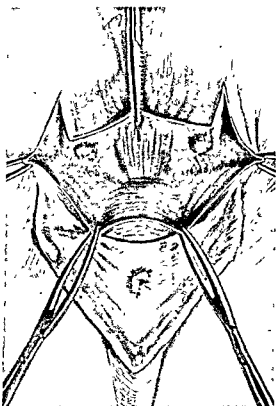


Fig. 1274.—Operation for complete rupture of the perineum. Incisions are carried downwards and outwards from each lateral angle to assist in exposing the ends of the torn sphincters which are further freed in dissection.

Traction is made on the forceps attached to the anterior rectal wall which is freed and stripped from its attachments so that it can be pulled downwards without tension. The anterior wall of the rectum, which has been drawn downwards to the anal verge, is secured in this position after suturing together the two ends of the ruptured sphincter ani muscle. Care must be taken not to perforate the rectal wall during the process of suturing (fig. 1275).

The posterior vaginal wall is reconstructed after the removal of a small V-shaped portion. The anterior edges of the levatores ani muscles are approximated with interrupted stitches and the perineal body restored. The two lower stitches holding the levatores ani muscles, and also those restoring the perineal body, should include small bites of the anterior rectal wall. These lower stitches should also approximate the tissues in the neighbourhood of the extremities of the torn sphincter ani muscle (fig. 1275).

The skin of the perineum is sutured by interrupted catgut or silk-worm-gut stitches, the lowest of which should include the lower edge of the flap of rectum which was previously pulled downwards outside the sphincter (figs. 1275, 1276 and 1277).

The operation described is usually performed without difficulty; occasionally the rectal wall is so fixed owing to the presence of scar tissue that it cannot be pulled downwards to the level of the sphincter without undue tension. In such cases an attempt should be made to divide the anchoring cicatrix, even though it proves necessary to carry the dissection as high as the cervix. Should this be impossible, the divided portion of the rectum should be sutured with two rows of continuous catgut stitches, which, however, must not penetrate the mucosa.

Advantages. An impervious anterior rectal wall is at once obtained and there is no leakage of liquid bowel contents into the field of operation. The probabilities of suppuration are greatly diminished, but should infection occur there is less chance of the formation of a recto-vaginal fistula.

COMPLICATIONS OF PLASTIC VAGINAL OPERATIONS

(1) *Sepsis.* Suppuration is the commonest complication. It is more likely to occur after operations for complete perineal rupture, as in such cases the anal canal has been opened, rendering contamination of the wound almost unavoidable.

After the flap of rectal wall has been fixed to the sphincter ani muscle, the raw area should be swabbed with pure eusol, and a fresh set of instruments and gloves be substituted.

If suppuration occurs, only the superficial stitches should be removed. The vagina is then irrigated three or four times daily with concentrated saline solution (sod. chloride, $\frac{1}{2}$ oz. to the pint), and dressed with gauze soaked in glycerine. The deeper stitches do not

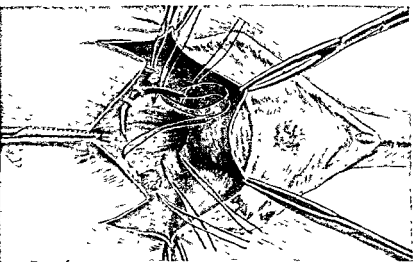


Fig. 1216.—OPERATION FOR COMPLETE RUPTURE OF THE PERINEUM. THREE SUTURES ARE PASSED APPROXIMATING THE ANTERIOR EDGES OF THE LEVATOR ANI MUSCLES. THE RECTAL WALL HAVING BEEN DISSECTED FREE IS NOW DRAWN UP, DOWN AND ITS ANTERIOR SURFACE IS INCORPORATED IN A SUTURE WHICH APPROXIMATES THE DIVIDED ENDS OF THE SPHINCTER ANI MUSCLE. THIS PREVENTS THE ANTERIOR RECTAL WALL FROM RETRACTING UPWARDS.

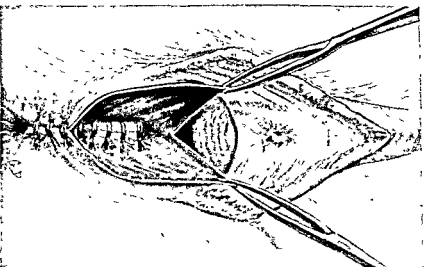


Fig. 1217.—OPERATION FOR COMPLETE RUPTURE OF THE PERINEUM. THE ANTERIOR EDGES OF THE LEVATOR ANI MUSCLES ARE SUTURED TOGETHER. THE ANTERIOR RECTAL WALL HAVING BEEN SECURED OUTSIDE THE SPHINCTER, THE PERINEAL BODY IS RESTORED AND THE SKIN SUTURED WITH INTERRUPTED SUTURES.

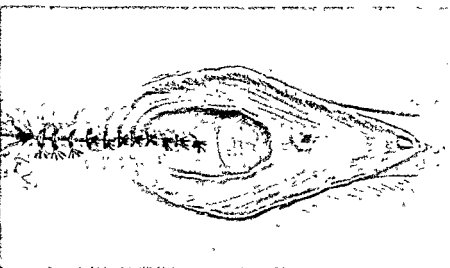


Fig. 1217.—OPERATION FOR COMPLETE RUPTURE OF THE PERINEUM. THE EDGES OF THE CUT VAGINAL WALL AND PERINEAL SKIN HAVE BEEN APPROXIMATED WITH INTERRUPTED SUTURES.

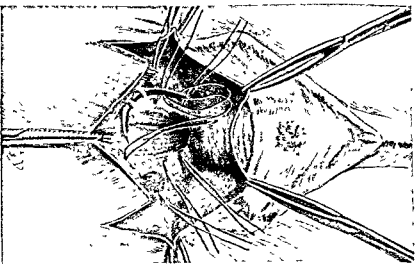


Fig. 1275.—OPERATION FOR COMPLETE RUPTURE OF THE PERINEUM. THREE STITCHES ARE PASSED APPROXIMATING THE ANTERIOR EDGES OF THE LEVATOR ANI MUSCLE. THE RECTAL WALL HAVING BEEN DISSECTED FREE IS NOW DRAWN WELL DOWN AND ITS ANTERIOR SURFACE IS INCLUDED IN A STITCH WHICH APPROXIMATES THE DIVIDED ENDS OF THE SPHINCTER ANI MUSCLE. THIS PREVENTS THE ANTERIOR RECTAL WALL FROM RETRACTING UPWARDS.

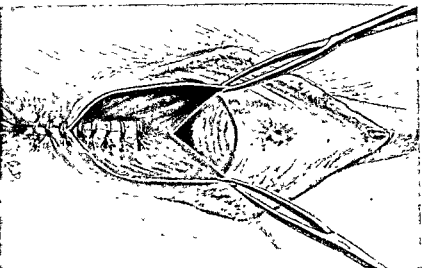


Fig. 1276.—OPERATION FOR COMPLETE RUPTURE OF THE PERINEUM. THE ANTERIOR FOLDS OF THE LEVATOR ANI MUSCLE ARE STITCHED TOGETHER. THE ANTERIOR RECTAL WALL HAVING BEEN SECURED OUTSIDE THE SPHINCTER, THE PERINEAL BODY IS RESTORED AND THE SKIN SUTURED WITH INTERRUPTED STITCHES.

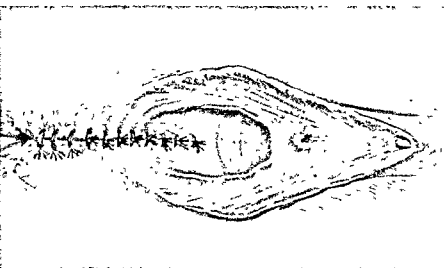


Fig. 1277.—OPERATION FOR COMPLETE RUPTURE OF THE PERINEUM. THE FOLDS OF THE CUT VAGINAL WALL AND PERINEAL SKIN HAVE BEEN APPROXIMATED WITH INTERRUPTED STITCHES.

The posterior vaginal wall is reconstructed after the removal of a small V-shaped portion. The anterior edges of the levatores ani muscles are approximated with interrupted stitches and the perineal body restored. The two lower stitches holding the levatores ani muscles, and also those restoring the perineal body, should include small bites of the anterior rectal wall. These lower stitches should also approximate the tissues in the neighbourhood of the extremities of the torn sphincter ani muscle (fig. 1275).

The skin of the perineum is sutured by interrupted catgut or silk-worm gut stitches, the lowest of which should include the lower edge of the flap of rectum which was previously pulled downwards outside the sphincter (figs. 1275, 1276 and 1277).

The operation described is usually performed without difficulty; occasionally the rectal wall is so fixed owing to the presence of scar tissue that it cannot be pulled downwards to the level of the sphincter without undue tension. In such cases an attempt should be made to divide the anchoring cicatrix, even though it proves necessary to carry the dissection as high as the cervix. Should this be impossible, the divided portion of the rectum should be sutured with two rows of continuous catgut stitches, which, however, must not penetrate the mucosa.

Advantages. An impervious anterior rectal wall is at once obtained and there is no leakage of liquid bowel contents into the field of operation. The probabilities of suppuration are greatly diminished, but should infection occur there is less chance of the formation of a recto-vaginal fistula.

COMPLICATIONS OF PLASTIC VAGINAL OPERATIONS

(1) *Sepsis.* Suppuration is the commonest complication. It is more likely to occur after operations for complete perineal rupture, as in such cases the anal canal has been opened, rendering contamination of the wound almost unavoidable.

After the flap of rectal wall has been fixed to the sphincter ani muscle, the raw area should be swabbed with pure eusol, and a fresh set of instruments and gloves be substituted.

If suppuration occurs, only the superficial stitches should be removed. The vagina is then irrigated three or four times daily with concentrated saline solution (sod. chloride, $\frac{1}{2}$ oz. to the pint), and dressed with gauze soaked in glycerine. The deeper stitches do not

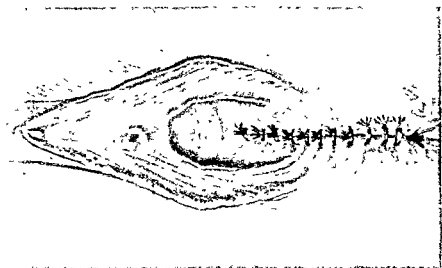


Fig. 1277.—Operation for complete rupture of the perineum. The edges of the cut vaginal wall and perineal skin have been approximated with interrupted sutures.

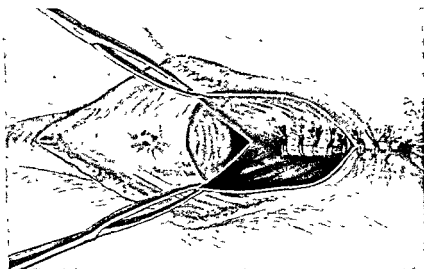


Fig. 1276.—Operation for complete rupture of the perineum. The anterior edges of the levator ani muscles are sutured together. The anterior rectal wall has been secured outside the sphincter, the perineal body is restored and the skin sutured with interrupted sutures.

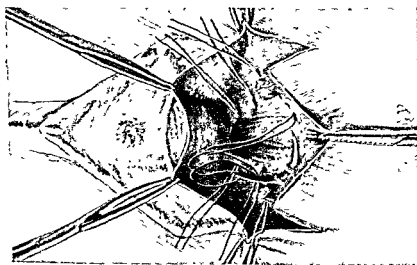


Fig. 1275.—Operation for complete rupture of the perineum. The levator ani muscles are sutured together. The anterior rectal wall has been dissected and is now drawn well down and its anterior surface is included in a suture which approximates the divided ends of the sphincter ani muscle. This prevents the anterior rectal wall from retracting upwards.

usually give way in spite of suppuration, and the final result is generally satisfactory. If the wound breaks down entirely, hot fomentations are applied until healing is well established, and further operation is postponed for six months.

(2) *Hæmorrhage.* Free oozing almost invariably occurs during operation, and active bleeding is usually seen in the cut edge of the vagina and the anterior rectal wall. These bleeding vessels should be carefully tied. If a hæmatoma forms, the wound should be opened up and re-sutured after the clot has been evacuated and the bleeding points secured.

(3) *Vaginal adhesions.* The anterior and posterior suture lines may become partially adherent, causing dyspareunia or apareunia. Incontinence of urine may also occur as a result of downward and backward pull on the floor of the urethra.

Adhesions are prevented by passing a douche nozzle and separating the walls. Examination should be made two weeks after operation to ascertain whether any such adhesions have formed, and if present they should be broken down with the finger, aided by scissors if necessary. The vagina is then packed with gauze soaked in sterile liquid paraffin. A finger is passed twice weekly, the walls are separated, and a light pack soaked in paraffin is again inserted.

OPERATION FOR RECTO-VAGINAL FISTULA

After the tissues intervening between the fistula and the surface of the perineum have been divided, the steps of this operation are the same as those described under the operation for complete rupture of the perineum (see page 2408).

Procedure. The lower edge of the vagina, at the level of the posterior ends of the labia majora, is held on each side with a pair of forceps.

A probe is passed into the fistula and directed downwards and backwards through the anal orifice. The bridge of tissues between the fistula and the perineum is then divided.

The forceps holding the lower edge of the vagina are widely retracted, and the line of demarcation between the rectum and vagina is exposed by cutting through the upper margin of the fistula. The vagina and rectum are freed, and are then separated by gauze pressure up to the level of the cervix.

The anterior rectal wall is freed by dissection until its lower edge can be pulled down to a point just below the level of the sphincter ani.

The operation then proceeds as for repair of complete perineal rupture (see page 2408).

OPERATIONS FOR VESICO-VAGINAL FISTULA VIA THE VAGINA

Vesico-vaginal fistulæ may be closed via the vaginal or the abdominal route (see page 2943).

Vaginal operation. Two methods are employed :

- (1) Trimming and suture.
- (2) Flap formation and suture.

(1) *Operation by trimming and suture.* The bladder is washed out with saline solution, a sound is passed, and the exact size and position of the fistula is determined. The vaginal wall around the opening is picked up with forceps, and the fistulous tract is coned out.

The opening is closed with a series of interrupted sutures which include all the tissues except the vesical mucosa.

There may be so much scar tissue around the fistula that approximation is difficult until the vaginal wall on each side has been mobilised by making two parallel incisions.

Dressings and After-Treatment. An indwelling catheter is inserted into the bladder and stitched into place. The vagina is lightly packed with gauze soaked in liquid paraffin in flavine (1 in 2000) for 24 hours. The bladder is washed out twice daily with boric lotion through the catheter, and urinary antiseptics, such as urotropine, 10 grs., with acid sodium phosphate, 20 grs., are given t.d.s., to reduce the likelihood of urinary infection.

(2) *Operation by flap formation and suture.* This operation is a little more difficult to perform than the one just described, but it is more likely to be successful, especially if the fistula is large.

The vaginal mucosa is picked up with Allis forceps about $\frac{3}{4}$ inch away from the opening. A crescentic incision with the convexity forwards is now made around the fistula at a distance of $\frac{3}{4}$ inch from it, the two horns of the crescent being near the two guide forceps. This flap of mucosa, which is traversed by the fistula, is dissected up from the underlying bladder, and the vaginal wall surrounding the raw area is undercut to separate it from the base of the bladder.

The epithelial lining of the opening in the bladder is excised and a purse-string suture of No. 1 20-day catgut is inserted around the opening, picking up bladder wall but not penetrating the mucosa. This suture, when tied, not only closes the opening, but inverts it into the bladder. Two or three fine interrupted stitches are then passed to reinforce the purse-string suture.

The flap is trimmed and sewn to the edges of the vaginal incision with interrupted sutures. If the flap is large two or three mattress sutures can be inserted so as to approximate the deep surfaces and evert the edges towards the vagina. This has the advantage of giving a wider surface of co-aptation and increasing the distance between the epithelial linings of the bladder and vagina.

OPERATIONS FOR ATRESIA OF THE VAGINA

The operative treatment of the following types of atresia of the vagina will be described :

- (1) Atresia of the vagina due to the presence of a transverse septum.
- (2) Incomplete formation of some portion of the vagina.
- (3) Complete absence of the vagina.

Indications. Operation is indicated in order to liberate retained menses and to establish capacity for coitus.

Atresia due to a Transverse Septum. The commonest cause of vaginal atresia and cryptomenorrhœa is a transverse septum. The septum is usually situated at the lower end of the vagina, the hymen being stretched over the periphery of its superficial surface ; in some cases, however, such septa may be perforated in the centre.

Operation for the Removal of a Complete Septum. Procedure. An incision is made in the bulging septum from before backwards, and the pent-up tarry blood and mucus is allowed to escape. If the vagina only is distended the retained fluid is completely removed with gauze mops ; if, however, the uterus also is distended the fluid should simply be left to drain away after removing the septum. The septum is excised all around and the cut edges are oversewn with catgut stitches.

The two main *dangers* associated with the condition are sepsis and hæmorrhage.

Sepsis is due to infection of the retained fluid with organisms which thrive readily in this medium. Infection may spread to the tubes, pelvic peritoneum, or even to the blood stream, often proving fatal.

Hæmorrhage may occur when a distended Fallopian tube ruptures. In cases of hæmatosalpinx there is usually an associated peritonitis in which the friable and distended tube becomes anchored by adhesions, and may rupture during a vaginal examination or when the dilated uterus empties and shrinks. Following excision of the septum the patient must be kept under constant observation for several hours for signs and symptoms of intra-peritoneal bleeding. Should there be evidence of such a catastrophe, the abdomen must be opened immediately and salpingectomy performed. If all goes well after the removal of the septum, no attempt should be made to determine the condition of the tubes by vaginal examination for at least three weeks or until all drainage of the retained fluid has ceased. If at the end of this time the distended tubes can be distinctly identified, they should be excised.

Dressings and After-Treatment. The vulva is dressed with gauze soaked in eusol and covered with oiled silk and cotton wool. These dressings are changed at least three times a day, or whenever they become saturated with the discharge. After all evacuations, the vulva and surrounding areas are swabbed with 1 in 40 lysol or dettol solution. To facilitate drainage the sitting posture should be maintained during convalescence. Should there be a rise of temperature indicating sepsis, a large gum elastic catheter should be passed into the uterus and glycerine ($\frac{1}{2}$ oz.) injected four times a day.

Incomplete Formation of Some Portion of the Vagina. Usually the lower part of the vagina is affected, rarely the middle or upper part. Operation is indicated on account of retention of menses and in order to establish sexual capacity.

Procedure. When there is atresia at the lower end of the vagina the operation is conducted as follows :

A sound is inserted into the bladder to define its position, and the left index finger is passed into the rectum. A transverse incision, two inches long, is made half way between the urethra and the anal margin, and deepened so as to open up the cellular tissues between the rectum and the urethra. Blunt dissection is now made with the fingers of the right hand, or with the scissors, the blades of which are pushed into the space and then opened. In this manner the bladder

and rectum are separated until the distended part of the vagina is reached. This is opened and the retained fluid is evacuated.

If this newly-made passage leading to the vagina is very short, an attempt should be made to free the skin at the entrance and to suture this to the lining of the vagina so as to cover the raw area. When this is impossible the uncovered surface is left to granulate. The new canal is kept open with dilators until the epithelium from the vagina and the surrounding skin grows over and covers the raw surface.

Dressings and After-Treatment. Careful antiseptic measures are employed to prevent infection. A perforated hollow dilator of chosen size should be inserted and left in place for several hours each day for some weeks or months until the raw surfaces become epithelialised. If all efforts to maintain the patency of the new opening fail, total hysterectomy should be advised.

Complete Absence of the Vagina. When such a condition occurs, a vagina may be constructed. This operation is only undertaken to establish capacity for sexual intercourse, and it should be limited to women who are married or who are about to marry. Its risks, nature and limitations should be fully explained to those immediately concerned.

The essentials of this operation are :

(a) The opening up of a space between the bladder and the urethra in front and the rectum behind.

(b) The permanent establishment of the space :

- (i) By the use of dilators to prevent contraction, and by skin grafting with the aid of a stent mould ;
- (ii) By lining the passage with a loop of small intestine, or a portion of sigmoid colon ; or
- (iii) By the construction of a pedicled tubular flap of skin raised from the inner aspect of the thigh, as recommended by Frank and Geist (*Bickham's Operative Surgery*, Vol. vii, p. 563. Saunders, 1933).

The operation most commonly performed for this condition is (i) which calls for no detailed description. Method (iii), recommended by Frank and Geist, is difficult and complicated. By method (ii) the passage is lined with a segment of either small intestine (Baldwin's operation), or large intestine (Rock Carling's operation).

When a loop of *small intestine* is used, the operation is conducted as follows :

The patient is placed in the lithotomy position. A bladder sound having been inserted and the left index finger passed into the rectum, a transverse incision, two inches long, is made half way between the urethra and the anal margin. Dissection with the fingers of the right hand or with the scissors is then made upwards between the bladder and rectum until the peritoneum is reached. A pair of ring forceps is then inserted to the top of this new opening, and kept in position by gauze packing.

The patient is then placed in the Trendelenburg position and the lower abdomen is opened by a medial incision. The ileum is examined to find a portion with sufficient length of mesentery to allow a coil to be brought down to the perineum.

If the mesentery of the small bowel is not sufficiently long for this purpose, a loop of sigmoid colon may be chosen instead. If it is possible to use a loop of ileum, a portion of bowel, seven inches long, is selected and drawn through the wound, the surrounding area being packed off.

The proximal and distal limbs of the selected portion of gut are crushed at a distance of seven inches apart and divided. Then, after cutting through the mesentery in such a manner as not to interfere with its blood supply, but at the same time sufficiently to permit of free mobilisation of the isolated segment of ileum, the continuity of the intestinal tract is established by end-to-end anastomosis, the ends of the isolated loop being first closed and inverted.

It is important that the isolated segment should lie on the pelvic side of the newly restored mesentery. When the abdominal packs have been removed, the vulva is exposed and the ring forceps in the passage are pushed upwards so as to bulge the peritoneum between the bladder and rectum. This fold of peritoneum is then picked up and incised sufficiently to allow the loop of bowel to be pulled through it. The ring forceps are then pushed up through this opening and the middle portion of the segment of bowel is gripped, drawn back through the opening in the peritoneum and down through the space between the bladder and rectum. The segment of gut is then U-shaped, the closed ends being uppermost. On account of the shortness of the mesentery, considerable difficulty may be encountered in drawing the whole segment through the peritoneal opening. When, however, this has been satisfactorily accomplished, the opening in the peritoneum at the bottom of the pelvis, through which the gut has been drawn, is

sutured to the mesentery and the abdominal wound is closed in the usual manner.

The patient is then again placed in the lithotomy position. The apex of the segment is drawn down to the vulva, opened by an incision in its long axis, and the margins of this opening are stitched with interrupted catgut sutures to the edges of the incision in the perineum. There is now a double "vagina."

Three months later the two limbs of the U-shaped loop are converted into a single passage by crushing the septum with an enterotribe, the instrument being left in position until it comes away by sloughing of the tissues. The results of this operation are usually satisfactory.

When a vagina is formed from a portion of *sigmoid colon* the operation is in many respects similar to that just described. The advantages of this method appear to be that the segment can be brought down without undue tension on its mesentery.

OPERATIONS FOR VAGINISMUS

Operations for vaginismus entail either :

- (1) Excision of the hymen (figs. 1278 and 1279) ; or,
- (2) Enlargement of the vaginal entrance (Fenton's operation).

Removing the hymen. The hymen should be removed when it is tough and resistant, or where tender lacerations or remnants (*carunculæ hymenales*) are present.

Procedure. A small, frequently tender crescent of the hymen is present on each side of the urethra, which considerably limits the size of the entrance. Such crescents are cut through and the entrance thoroughly stretched. The resultant oozing may be controlled by packing, but more effectually with a catgut stitch.

If the hymen is unruptured, the edge is picked up with forceps and its base of attachment is cut away all around the vaginal entrance (fig. 1279). The entire hymen must always be removed. Firm pressure with the thumbs may then be made backwards and outwards to stretch the introitus.

Enlargement of the vaginal entrance. This is a more effective procedure than merely excising the hymen and stretching the entrance.

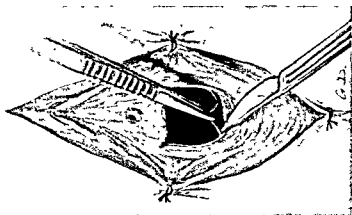


Fig. 1280.—ENLARGEMENT OF THE VAGINAL ENTRANCE. THE LOWER EDGE OF THE POSTERIOR VAGINAL WALL IS PICKED UP WITH FORCEPS AND DISSECTED FREE FROM THE UNDERLYING PERINEAL BODY.

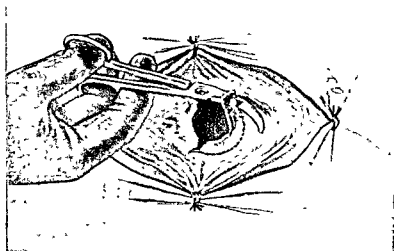


Fig. 1279.—EXCISION OF THE HYMEN. THE POSTERIOR PART OF THE HYMEN IS CIRCUMFERENTIALLY EXCISED WITH CURVED SCISSORS.

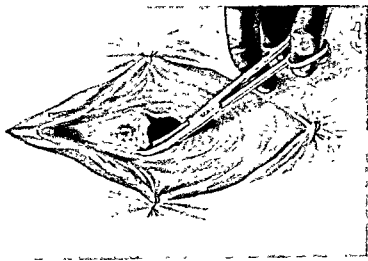


Fig. 1278.—UNION OF THE HYMEN. SUTURE INCISIONS ARE MADE THROUGH THE SMALL CUSPETS OF THE HYMEN WHICH LIE POSTERO LATERALLY TO THE URETHRAL MEATUS.

Procedure. After excision of the hymen, the cut edge of the mucous membrane of the vagina in the mid-line posteriorly is held with forceps, and a flap about 1 inch wide is dissected up until the perineal body is exposed (fig. 1280). An incision is now made in the mid-line to divide the perineal body to a depth of 1 inch, together with the fourchette

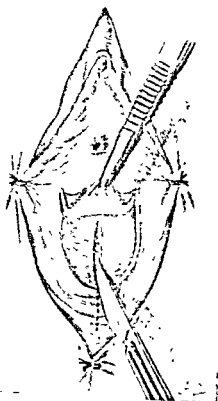


Fig. 1281.—ENLARGEMENT OF THE VAGINAL ENTRANCE. THE POSTERIOR VAGINAL WALL HAVING BEEN DISSECTED UP FOR A SHORT DISTANCE, THE PERINEAL BODY IS SPLIT WITH A SCALPEL AND THE INCISION IS CARRIED BACKWARDS FOR A SHORT DISTANCE THROUGH THE FOURCHETTE AND SKIN OF THE PERINEUM.

and the skin of the perineum half way to the anus (fig. 1281). The finger is inserted and pressed backwards, further stretching and rupturing the perineal body (fig. 1282).

The central part of the vaginal flap is now pulled backwards and fixed with a catgut stitch to the cut edge of the skin in the mid-line. A continuous suture or interrupted catgut stitches complete the attachment of the flap to the incision in the perineal skin (fig. 1284).



Fig. 1284.—ENLARGEMENT OF THE VAGINAL ENTRANCE. THE SUTURING COMPLETED. THE VAGINAL ENTRANCE IS NOW VERY MUCH ENLARGED POSTERIORLY, AND IS SLOPING INWARDS AND UPWARDS, THE FOUR-CHETTE HAVING DISAPPEARED.

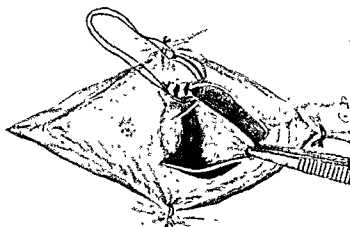


Fig. 1283.—ENLARGEMENT OF THE VAGINAL ENTRANCE. THE FLAP OF POSTERIOR VAGINAL WALL IS NOW PULLED DOWNWARDS AND BACKWARDS, AND ITS EDGE IS UNITED TO THE POSTERIOR SKIN EDGE BY A CONTINUOUS SUTURE OF CATGUT.

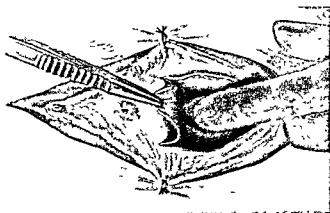


Fig. 1282.—ENLARGEMENT OF THE VAGINAL ENTRANCE. A FINGER IS NOW PRESSED AGAINST THE DIVIDED PERINEAL BODY SO AS TO SPREAD IT FURTHER AND TO STRIKE THE VAGINAL ENTRANCE.

OPERATION FOR EXCISION OF A LONGITUDINAL SEPTUM OF THE VAGINA

Procedure The lower edge of the septum is drawn forwards and the line of attachment to the posterior wall is cut through with scissors up to the vault. The anterior attachment is then similarly divided, after which the septum is pulled downwards and separated with scissors from its attachment to the vault.

The wounds on both anterior and posterior walls are oversewn with catgut.

OPERATION FOR HERNIA OF THE POUCH OF DOUGLAS

Procedure The bulging vaginal wall is picked up with forceps and drawn down to its full extent. The portion near the vault is circumscribed by an oval or circular incision which divides only the vaginal wall. This portion of the wall is separated from the underlying peritoneal sac by sharp dissection and gauze pressure.

The sac is then opened, care being taken to avoid injury to the bowel. The utero-sacral ligaments are identified and stitched together from side to side, no space being left between their approximated edges and the anterior wall of the rectum behind and the cervix in front. The rectum must not be constricted. The approximation of the utero-sacral ligaments is the most important step in the operation. The loose peritoneum on either side below these ligaments is sewn together from side to side with catgut and the redundant portion is cut away.

The cut edges of the vagina are sutured with catgut.

Where the utero-sacral ligaments are sutured together in the manner just described, a permanent cure may be expected. Where, however, this method proves impossible, the operation should be carried out through the abdomen.

COLPOTOMY

Colpotomy is the operation of opening the peritoneal cavity through the posterior vaginal fornix, usually in order to drain a pelvic abscess.

Procedure. An Auvard speculum having been inserted into the vagina, the posterior lip of the cervix is drawn forwards with a vulsellum. An incision about 1 inch long is made transversely across the posterior fornix where the vagina joins the cervix, and this incision is deepened until the cellular tissues outside the peritoneum are reached (fig. 1285).

The edges of the incision are retracted and uterine forceps are pressed into this space and opened; a finger is then inserted to effect

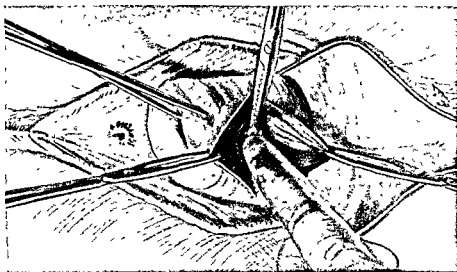


Fig. 1287.—Colotomy. A fold of peritoneum is tickled up and palpated with the finger to ensure that no portion of bowel is included; this fold is then incised.

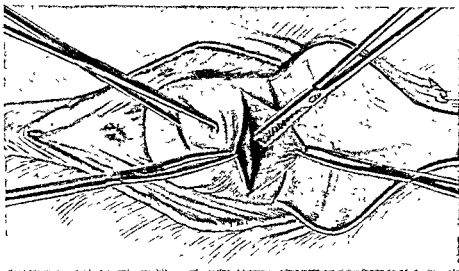


Fig. 1288.—Colotomy. The cut edges of the vagina are retracted and further separated by inserting and opening a pair of artery forceps.

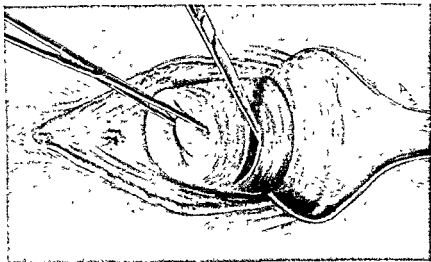


Fig. 1285.—Colotomy. The posterior lip of the cervix is drawn well forwards, and the tightened vaginal wall near its junction with the cervix is then incised transversely down to the parietum.

further separation (figs. 1286 and 1287). The peritoneum is identified and a small pleat is picked up with artery forceps and divided close to the posterior wall of the uterus. The uterine forceps are now passed

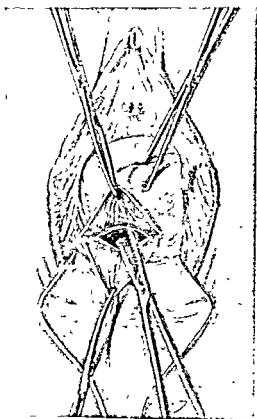


Fig 1288.—COLPOTOMY. A PAIR OF FORCEPS IS PASSED TO WIDEN THE OPENING IN THE PERITONEUM, OR THEY MAY BE USED TO OPEN UP AN ABSCESS IN THE PELVIS.

through this hole and gently opened (fig. 1288). If an abscess has been opened, a rubber tube about $\frac{1}{2}$ inch in diameter is passed well into the cavity and stitched to the edge of the vaginal opening with plain catgut to afford free drainage.

OPERATION FOR VAGINAL CYSTS

Vaginal cysts are most commonly seen low down in the anterior wall, in which situation they are frequently due to cystic dilatation of Schuller's glands. They may communicate with the urethra—*urethrocele*. Occasionally a cyst of the Wolffian duct (Gartner's duct) forms high up in the vaginal vault on one side; this may be large, extending upwards by the side of the uterus, in which case it is best to remove it via the abdomen or attempt treatment by the injection method.

OPERATIVE TREATMENT

Procedure. An Auvar'd speculum is inserted into the vagina, and a bladder sound is passed into the urethra to determine whether there is a communication between it and the cyst. A curved incision is made on each side of the swelling and the cyst is isolated by dissection. If there is a channel communicating with the urethra it is ligated and the cyst is cut away; the vaginal incision is then closed with one or two mattress and a few interrupted sutures.

In operating upon large vaginal cysts there is risk of injuring the bladder, urethra or rectum, and hæmorrhage may even be serious. In such cases, the cyst should be opened, and its wall with the overlying vagina trimmed away, leaving the cavity as part of the vaginal wall. The cyst lining will subsequently undergo metaplasia into stratified epithelium.

INJECTION TREATMENT

This consists of tapping the cyst and then injecting it with a sclerosing fluid, similar to the method adopted by Maingot in the treatment of hydrocele. The lining cells are thus destroyed, with the result that the walls adhere together and obliterate the cavity. This method is applicable to large cysts or to those high in the pelvis e.g. arising from the Wolffian duct.

Special Instruments. Maingot's cannula, an exploring needle, Record syringe, and sclerosing fluid: (lithocaine: lithium salicylate, 30 per cent, tutocaine, 1 per cent, in distilled water).

Procedure. The trocar and cannula are thrust into the cyst and the fluid allowed to escape into a measuring flask. This fluid should be measured. Sclerosing fluid, in amount equal to that withdrawn, is then injected so that the cavity is completely filled and the solution is in contact with the entire lining. This is left in the sac for a few minutes and then all except a small quantity is withdrawn.

VAGINAL HYSTERECTOMY

The *advantages* of removing the uterus through the vagina rather than through the abdomen are that shock is slighter, convalescence is rarely prolonged, and bowel disturbances are negligible. Moreover, hysterectomy and the repair of a prolapse can be combined in the same procedure if necessary.

The *indications* for the operation are identical with those for abdominal hysterectomy (see page 2477).

The vaginal route is chosen in preference to the abdominal route where there is:

- (1) Chronic cardiac or pulmonary disease.
 - (2) Pronounced obesity.
-

- (3) General debility due to prolonged hæmorrhage or wasting diseases.
- (4) Senility.
- (5) The presence of a colostomy or skin affection which would predispose to infection in cases of abdominal section.

The *contra-indications* to the performance of vaginal hysterectomy are :

(1) Large size of the uterus. The operation becomes increasingly difficult in proportion to the size of the uterus, which must be small enough to pass through the pelvic opening, i.e. not larger than the size of a full-term foetal head.

(2) Fixity of the uterus. A previous ventro-fixation or extensive adhesions preclude the performance of this operation.

(3) The presence of other intra-abdominal lesions, such as a diseased appendix or an ovarian tumour.

(4) Small size of the vagina. This renders the operation extremely difficult although not impossible. A para-vaginal incision helps to overcome this difficulty.

METHODS

- (1) The fundus of the uterus is drawn out through an opening in the anterior fornix and its attachments are divided from above downwards (see page 2433).
- (2) The para-cervical tissues and broad ligaments are divided from below upwards (see page 2436).
- (3) The uterus is split in two, and each half is removed separately (figs. 1289 and 1290).

DANGERS

(1) *Injury to the bladder* is probably the most likely mishap, and laceration may occur during its separation from the cervix and lower uterine segment. This liability is increased if previous operations for repair have been attempted, or if the case is one of long-standing prolapse, with fibrous adherence of the bladder to the uterus and cervix. The presence of a small fibroid in the anterior wall of the uterus also increases the danger. The bladder may also be opened in mistake for the anterior peritoneal pouch.

These dangers can be minimised by emptying the bladder with a

catheter at the start of the operation and by extreme care in identification of the plane of separation between the bladder and the uterus. The peritoneum can be recognised as a thin fold which moves freely over the anterior surface of the uterus. The bladder musculature is thick and its fibres run transversely. The exact position and limitations of the bladder can always be demonstrated with a sound.

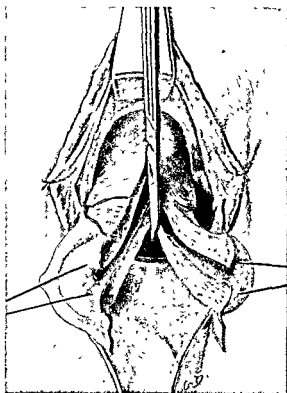


Fig. 1289.—VAGINAL HYSTERECTOMY. THE BLADDER HAVING BEEN RETRACTED UPWARDS, THE UTERO-VESICAL POUCH OPENED ANTERIORLY AND THE POUCH OF DOUGLAS POSTERIORLY, AND THE VAGINA SEPARATED FROM THE CERVIX LATERALLY, THE CERVIX AND UTERINE BODY ARE SPLIT UP THE MID LINE, EACH HALF BEING RETRACTED LATERALLY.

(2) *Injury to the bowel.* The small intestine may be cut or punctured when opening the peritoneum or during the actual removal of the uterus.

This can be avoided by lowering the patient's head—Trendelenburg-lithotomy position, or by inserting a pack to keep the bowel away from the operation area when the peritoneal cavity is opened.

(3) *Hæmorrhage* may occur from three sites :

(a) The cut vaginal wall, especially the posterior edge where it is always free and continuous.

- (b) The branches of the uterine vessels at the side of the cervix, or the strip of uterine muscle to which the broad ligament is attached. Free bleeding may occur from the divided uterine and ovarian vessels where a wide removal for carcinoma is undertaken. Ligatures are prone to slip off the vessels in the ovario-pelvic ligament; transfixion or double tying is therefore undertaken as a precautionary measure. Should it be impossible to apply a ligature on any deep bleeding point it is quite safe to leave the vessel crushed in artery or ring forceps for 36-48 hours.
- (c) The raw surface of the bladder.



FIG. 1250.—VAGINAL HYSTERECTOMY. EACH HALF OF THE UTERUS IS RETRACTED TO THE OPPOSITE SIDE, AND IS REMOVED FROM ABOVE DOWNWARDS BY CUTTING THROUGH THE MUSCULATURE AT THE SIDE OF THE UTERUS.

- (4) *Injury to the ureters.* The exact position of the ureters must always be visualised; they run from behind forwards, $\frac{3}{4}$ inch lateral to the side of the cervix. They may be cut or included in a ligature, resulting in the formation of a fistula. The ureters must be avoided by dividing the para-cervical tissues as close as possible to the cervix.

The advantages of leaving a small strip of cervical muscle on each side are too apparent to require further comment.

It is helpful to pass large ureteric bougies before the operation is started, as the ureters can thus at once be identified by palpation.

(5) *Implantation of cancer cells.* This is liable to occur when the operation is performed for cancer of the cervix. The chances are considerably diminished by performing radical or partial colpohysterectomy. In the latter case a cuff of vagina is separated and tied so as to surround the growth. When carcinoma of the body of the uterus is present, cells or fragments of growth may be squeezed through the cervical canal. This is avoided by packing the cervix very tightly with a small strip of gauze. Cancer cells may also be disseminated into the wound by piercing the fundus with a stitch or vulsellum.

OPERATIONS FOR PROLAPSE

(A) When hysterectomy is not required.

(B) When hysterectomy is required :

(1) For non-malignant conditions.

(2) For malignant conditions.

Prolapse of the second and third degrees can be efficiently treated by vaginal operation. A ventro-fixation of the uterus is only necessary when there is fixed retroversion, salpingitis, or other conditions requiring abdominal operation. Frequently, however, prolapse is complicated by the presence of conditions demanding hysterectomy.

(A) OPERATION WHEN HYSTERECTOMY IS NOT REQUIRED

Fothergill's operation is the most satisfactory procedure for the cure of prolapse. It is particularly suitable for utero-vaginal prolapse in which there is inversion of the vaginal vault, supra-vaginal elongation of the cervix, laceration, infection or cervical hypertrophy. The operation includes anterior colporrhaphy, and the removal of a wedge-shaped flap from the vault and anterior vaginal wall, together with amputation of the cervix.

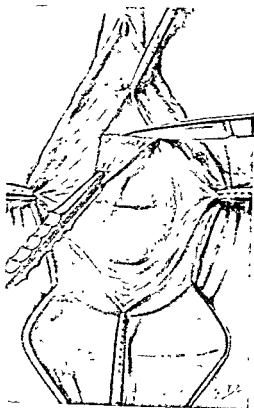


Fig. 1291.—FOTHERGILL'S OPERATION FOR PROLAPSE. THE VAGINAL WALL HAS BEEN SECURED AT FOUR POINTS.

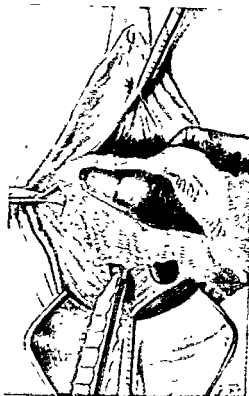


Fig. 1292.—FOTHERGILL'S OPERATION FOR PROLAPSE. THE FLAP FROM THE ANTERIOR VAGINAL WALL HAVING BEEN DISSECTED FREE AND RETRACTED BACKWARDS, THE BLADDER IS NOW STRIPPED BY GAUZE DISSECTION FROM THE FRONT OF THE CERVIX AND FROM THE ANTERIOR VAGINAL WALL ON EACH SIDE AND PUSHED UPWARDS.

Procedure. Preliminary dilatation and curettage are performed.

A flap is demarcated from four points—one immediately behind the urethral meatus, one about $\frac{1}{2}$ inch behind the posterior lip of the cervix in the mid-line, and one on each side and about $\frac{1}{2}$ inch from the cervix. Lines of incision sufficiently deep to penetrate the vaginal walls are now made, joining these points. The apex of this flap is picked up with a pair of forceps, and with sharp dissection the anterior inch is freed so that a plane of separation can be clearly identified (fig. 1291). The sub-vesical (pubo-cervical) fascia is stripped by gauze dissection from the vaginal flap which is steadily retracted downwards and backwards. Fibrous adhesions, if encountered, must be divided with scissors.

When the dissection has reached the level of the cervix the bladder reflection is exposed and freed. The bladder is then pushed upwards, and the vaginal wall behind and on each side of the cervix is dissected

up until the cervix is reached (fig. 1292). Keeping the knife close to the cervix, sharp dissection is carried upwards on each side of it to an extent depending upon the amount of the supra-vaginal elongation. The cervix is cut straight across so as to leave the uterus not more than 3 inches long. The flap of the vagina and the amputated portion of the cervix thus come away in one piece (fig. 1293).

The edges of the vagina are now sutured with a double strand of No. 1 40-day catgut to the cut end of the cervix. The first stitch is

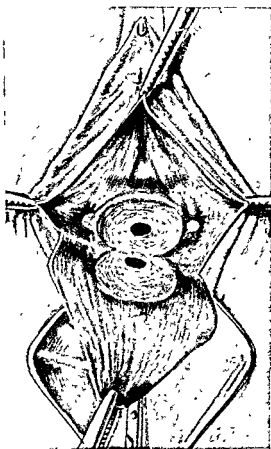


Fig. 1293.—FOTHERGILL'S OPERATION FOR PROLAPSE. THE CERVIX IS NOW CUT ACROSS, THE LENGTH REMOVED DEPENDING ON THE AMOUNT OF SUPRA VAGINAL ELONGATION. CERVICAL AND VAGINAL BRANCHES OF THE UTERINE ARTERY ON EACH SIDE HAVE BEEN LIGATED. THE VAGINAL WALL AT THE VAULT HAS BEEN DISSECTED FREE ALL AROUND.

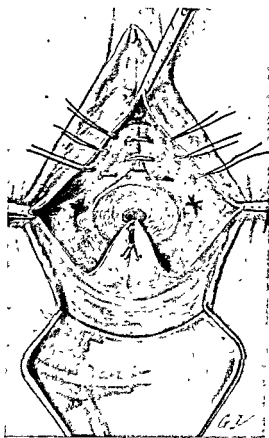


Fig. 1294.—FOTHERGILL'S OPERATION FOR PROLAPSE. THE SUB PUBIC FASCIA HAS BEEN PLEATED WITH THREE INTERRUPTED STITCHES. THE FOURTH STITCH PICKS UP A BITE OF CONNECTIVE TISSUE AT THE SIDE OF THE CERVIX ON EACH SIDE, AND PASSES THROUGH THE FRONT OF THE CERVIX IN THE MID-LINE. THIS LAST STITCH IS TIED AFTER THE SUTURE OF THE VAGINAL VAULT HAS BEEN COMPLETED. THE CUT EDGE OF THE VAGINAL WALL IN THE VAULT IS SUTURED TO THE END OF THE TRANSECTED CERVIX ALL AROUND. THE FIRST STITCH INSERTED IN THE MID-LINE POSTERIORLY SHOWS HOW THE VAGINA IS INFOLDED TO THE EDGE OF THE CERVICAL CANAL SO AS TO RECONSTRUCT THE NEW EXTERNAL OS. AS SUCCEEDING STITCHES ARE INSERTED ALTERNATELY ON EACH SIDE, THE CERVIX IS GRADUALLY PULLED BACKWARDS AND UPWARDS.

placed in the mid-line posteriorly, and others are inserted on each side alternately (fig. 1294). These successive sutures infold the cut edge of the vagina against the cervix, which recedes upwards and backwards as successive stitches are introduced (fig. 1295). When the cervical stump has been covered, the lateral edges of the cut vagina approach one another in the mid-line. Before the remaining portion of these edges is finally united, the bladder is further separated from

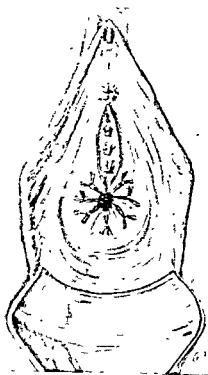


Fig. 1295.—FOTHERGILL'S OPERATION FOR PROLAPSE. SUTURE OF THE CUT EDGE OF THE VAGINA TO THE CERVIX HAS BEEN COMPLETED ALL AROUND. IN ACTUAL PRACTICE, THE NEW EXTERNAL OS POINTS ALMOST DIRECTLY BACKWARDS AND IS OUT OF SIGHT. THE SUTURES COMPLETING THE SUB-VESICAL FASCIA AND TIGHTENING THE LATERAL MASSES OF CONNECTIVE TISSUE ACROSS THE FRONT OF THE CERVIX HAVE BEEN TIED.

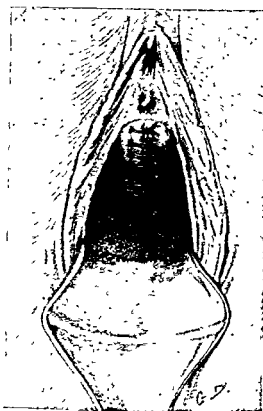


Fig. 1293.—FOTHERGILL'S OPERATION FOR PROLAPSE. THE OPERATION COMPLETE. THE CUT EDGES OF THE VAGINA IN THE MID-LINE ARE SUTURED; THE CERVIX IS FAR UP IN THE VAULT AND THE EXTERNAL OS IS POINTING BACKWARDS AND IS THEREFORE OUT OF SIGHT.

the anterior vaginal wall on each side and from the stump of the cervix and lower uterine segment posteriorly. When the bladder is pushed upwards the sub-vesical fascia can be pleated on each side of the middle line, the resulting folds being sewn together. Two or three interrupted catgut stitches are used; the last one is passed through the anterior wall of the lower uterine segment to prevent the bladder from sliding downwards and at the same time to form a new ligament of attachment for the uterus anteriorly.

The sides of the vagina are now sutured from the cervix forwards with a continuous stitch or interrupted sutures (fig. 1296).

The operation is completed by performing colpo-perineorrhaphy.

(B) OPERATION FOR PROLAPSE WHEN HYSTERECTOMY IS REQUIRED

Prolapse of the second or third degree is frequently associated with conditions which demand removal of the uterus. Vaginal hysterectomy, together with cure of prolapse, may be effected by one operation which must be modified in accordance with the condition demanding hysterectomy.

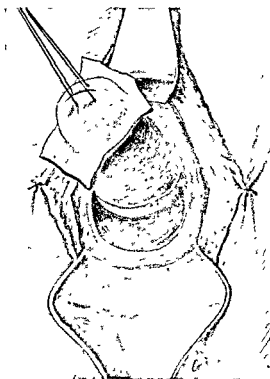


Fig 1297.—OPERATION FOR PROLAPSE PLUS VAGINAL HYSTERECTOMY FOR NON-MALIGNANT CONDITIONS. THE POUCH OF DOUGLAS HAS BEEN OPENED THROUGH THE POSTERIOR FORNIX.

(1) *Operation for prolapse combined with vaginal hysterectomy for non-malignant conditions.*

Procedure. Two stout catgut sutures are passed through the cervix and left long to act as tractors, or both lips of the cervix are grasped with a large vulsellum.

The vaginal flap is demarcated in the same manner as described under the operation for prolapse. This flap is then separated by

dissection and gauze pressure from the sub-vesical fascia in front and from the para-cervical tissues on each side of the cervix. The incision is carried posteriorly through the vaginal wall and peritoneum, opening the pouch of Douglas (fig. 1297). The bladder is freed from its attachment to the cervix, and is further stripped off the cervix by gauze pressure and pushed upwards. The anterior pouch of peritoneum is now opened (fig. 1298).

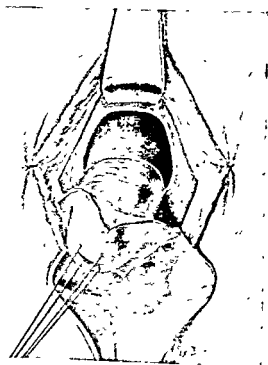


Fig 1298.—OPERATION FOR PROLAPSE PLUS VAGINAL HYSTERECTOMY FOR NON MALIGNANT CONDITIONS. THE BLADDER HAVING BEEN SEPARATED FROM THE VAGINA AND FRONT OF THE UTERUS, THE UTERO-VESICAL POUCH IS OPENED AND THE BLADDER IS RETRACTED UPWARDS. THE VAGINA HAS BEEN CUT FROM THE CERVIX Laterally.

If the uterus is not enlarged and is freely mobile, the fundus is tilted forwards through the opening previously made in the anterior peritoneal pouch, either with cat's-paw retractors or by applying tissue forceps to the anterior surface of the uterus at successively higher levels. A long double catgut tractor stitch is now passed deep through the fundus, and the fundus is pulled through the opening.

The broad ligament is next clamped and ligated, the needle being inserted through the broad ligament about 1 inch away from the uterus, and being carried over its upper border so as to include the round ligament, the Fallopian tube and the ovarian vessels. An

incision is made down the side of the uterus and cervix, leaving a narrow strip of muscle (fig. 1299). The main uterine vessels should not be divided, but the numerous branches in the strip of muscle left *in situ* are secured by mattress sutures of catgut. The opposite side of the uterus is freed in the same way.

Beginning at the lower end, the two strips of muscle to which are attached the broad ligaments above and the cervico-pelvic ligaments

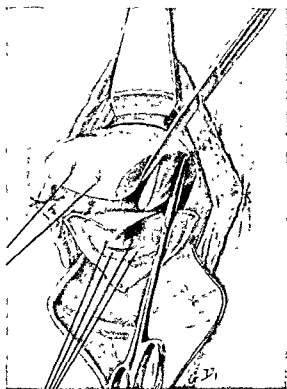


Fig. 1299.—OPERATION FOR PROLAPSE PLUS VAGINAL HYSTERECTOMY FOR NON MALIGNANT CONDITIONS. THE FUNDUS, HAVING BEEN WITHDRAWN THROUGH THE OPENING IN THE UTERO-VESICAL POUCH, IS DRAWN OVER TO THE RIGHT. THE FALLOPIAN TUBE AND THE UPPER BORDER OF THE LEFT BROAD LIGAMENT ARE CLAMPED, AND AN INCISION IS CARRIED DOWN THROUGH THE CORNU AND IN THE LATERAL WALL OF THE UTERUS SO AS TO LEAVE A THIN STRIP OF ITS MUSCULATURE WITH THE BROAD LIGAMENT ATTACHED.

below are now sutured together in the mid-line with interrupted stitches of doubled No. 1 catgut. This approximation tightens the cervico-pelvic ligaments and affords a firm sling for the vaginal vault (fig. 1301).

The peritoneal cavity in front is now closed by suturing the cut edge of the peritoneum to the top of the broad ligaments where they are joined in the mid-line.

The bladder is further stripped from the anterior vaginal wall and

the sub-vesical fascia is pleated with catgut stitches as in performing anterior colporrhaphy. Two or three interrupted stitches are used, the last of these picking up a bite of the sutured broad ligaments. This prevents the bladder from bulging downwards.

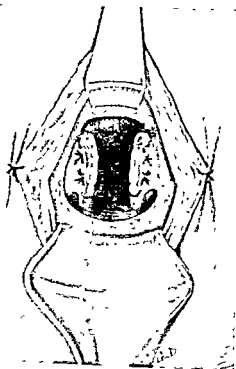


Fig. 1300.—OPERATION FOR PROLAPSE PLUS VAGINAL HYSTERECTOMY FOR NON MALIGNANT CONDITIONS. THE UTERUS HAS BEEN REMOVED AND THE STUMPS OF THE BROAD LIGAMENT, EACH WITH A THIN STRIP OF UTERINE AND CERVICAL MUSCLE ATTACHED, HAVE BEEN LIGATED WITH MATTRESS STITCHES.

The pouch of Douglas is now closed by sewing the posterior edges of the vagina and peritoneum to the back of the approximated broad ligaments.

The cut edges of the vaginal wall in each lateral fornix are brought together with interrupted mattress sutures which also pass through the junction of the approximated strips of muscle from the sides of the cervix. A continuous stitch finally unites the vaginal edges from the vault forwards and downwards towards the urethra (fig. 1302).

The operation is completed by performing colpo-perineorrhaphy (see page 2401).

(2) *Operation for prolapse combined with vaginal hysterectomy for carcinoma of the body of the uterus.*

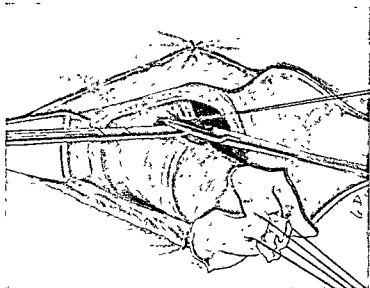


Fig. 1303.—OPERATION FOR PROLAPSE PLUS VAGINAL HYSTERECTOMY FOR CANCER OF THE BODY OF THE UTERUS. THE BLADDER IS SEPARATED FROM THE VAGINA AND FROM THE FRONT OF THE CERVIX, AND IS RETRACTED UPWARDS. THE POUCH OF DOUGLAS HAS BEEN OPENED THROUGH THE POSTERIOR FORNIX AND THE VAGINA HAS BEEN CUT FROM THE CERVIX LATERALLY. * IN THIS METHOD THE REMOVAL OF THE UTERUS IS CONDUCTED FROM BELOW UPWARDS BY CLAMPING, CUTTING, AND LIGATING SUCCESSIVE PORTIONS OF THE CERVICO-PELVIC LIGAMENTS AND THEN THE BROAD LIGAMENTS. THE CERVIX HAS BEEN PLUGGED TO PREVENT ESCAPE OF CARCINOMA CELLS.

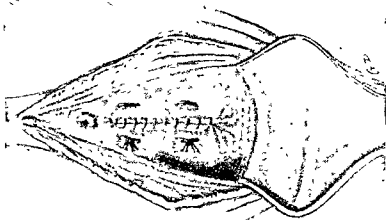


Fig. 1302.—OPERATION FOR PROLAPSE PLUS VAGINAL HYSTERECTOMY FOR NON MALIGNANT CONDITIONS. THE OPERATION COMPLETED.

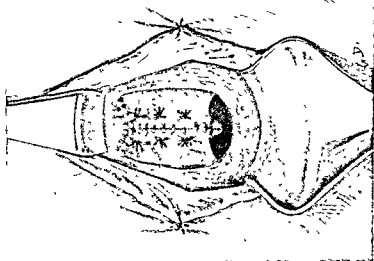


Fig. 1301.—OPERATION FOR PROLAPSE PLUS VAGINAL HYSTERECTOMY FOR NON MALIGNANT CONDITIONS. THE CERVICO-PELVIC AND BROAD LIGAMENTS ARE TIGHTENED BY SEWING TOGETHER IN THE MID LINE THE TWO STRIPS OF CERVICAL AND UTERINE MUSCLE. THE POUCH OF DOUGLAS IS CLOSED WITH A CATGUT STITCH WHICH UNITES THE EDGE OF THE PERITONEUM TO THE SUTURED CERVICAL MUSCLE IN THE MID LINE. THE EDGE OF THE PERITONEUM WHERE IT IS REFLECTED FROM THE BLADDER HAS BEEN SEWN TO THE UPPER EDGE OF THE UNITED BROAD LIGAMENTS. THIS STAGE IS COMPLETED BY FLATTENING THE SUBVASCULAR FASCIA.

This operation is in some respects similar to the one just described. The cervix is packed tightly before the tractor stitches are inserted, to ensure complete occlusion of the canal and to prevent escape of any detached fragments of the growth.

It is inadvisable to tilt the fundus forwards through the opening into the anterior peritoneal pouch, to grasp it with toothed forceps, or

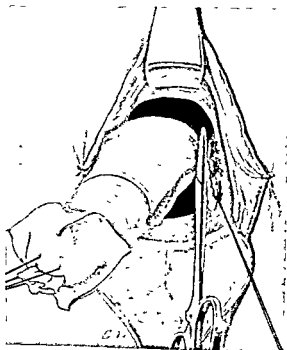


Fig 1304.—OPERATION FOR PROLAPSE PLUS VAGINAL HYSTERECTOMY FOR CANCER OF THE BODY OF THE UTERUS. THE FALLOPIAN TUBE AND UPPER BORDER OF THE BROAD LIGAMENT ARE CLAMPED AND LIGATED. THE TUBE AND OVARY ARE LEFT IN SITU, BUT THE ENTIRE UTERUS IS REMOVED.

to pierce it with a stitch, as to do so might disseminate carcinoma cells. The best method is to divide the uterine attachments from below upwards.

The cervix, having been freed from the vagina all round, is drawn downwards and to one side. A pair of artery forceps is now placed as close as possible to the cervix, clamping the para-cervical tissues to a depth of about 1 inch parallel to the cervix. These tissues are now cut medial to the forceps and secured with a blanket stitch immediately lateral to the forceps, which are removed as the ligature is tied. A bite on the opposite side of the cervix is taken, and the tissues are cut through and tied in the same way (fig. 1303).

The para-cervical tissues at a higher level on each side are clamped,

cut and tied. This greatly frees the uterus, which can be drawn down further, thus exposing the broad ligaments.

At this stage, the utero-sacral ligaments should, if possible, be identified, cut and tied through the opening in the pouch of Douglas, as this will further free the uterus and allow it to be brought down more readily.

The uterus is drawn downwards and to the right, and the uterine artery is located by picking up the broad ligament with the finger and thumb. This portion, including the vessels, is clamped and cut distal to the forceps, and then doubly tied, the ligatures being passed through the broad ligament wide of the vessels (fig. 1304). The uterus is then drawn to the opposite side and the other uterine vessels are similarly secured. The upper parts of the broad ligaments are now reached. The ovaries and Fallopian tubes are pulled down with forceps and a clamp is applied to the ovario-pelvic ligaments on each side. These are cut and the uterus is removed. Each ovario-pelvic ligament is doubly tied, the ligatures being inserted wide of the vessels; the first ligature is tied lateral to the clamp and the second in the groove made by the hæmostat.

The ligated stumps of para-cervical tissues and uterine vessels are drawn into the wound, and the peritoneal cavity is closed by stitching together the peritoneum of the pouch of Douglas behind, and that reflected from the bladder in front.

The sub-vesical fascia is pleated as in the previous operation, and the stumps of the para-cervical tissues and of the utero-sacral ligaments are drawn together with catgut sutures in the mid-line. The cut edges of the vaginal wall in the lateral and posterior fornices are approximated with interrupted mattress stitches of doubled No. 1 catgut. The anterior vaginal wall is finally sutured with a continuous stitch which oversews the cut edges.

Posterior colpo-perineorrhaphy completes the operation.

Dressings and After-Treatment. The vagina is thoroughly dried, swabbed with antiseptic solution, and then lightly packed with a strip of gauze soaked in liquid paraffin and flavine (1 in 2000). The pack is removed in 24 hours. Pain is always severe in these cases and morphia, $\frac{1}{4}$ gr., will be required for its relief.

The bladder should be catheterised every 6 hours for the first three or four days, or until there is spontaneous micturition. After each catheterisation argyrol 5 per cent, 2 drachms, is instilled into the bladder before the catheter is withdrawn. Douching is not advised, as fluid under pressure may separate the suture line and be carried into the peritoneal cavity, or the douche nozzle may be inadvertently pushed through the sutured vault. It is better to instil eusol, $\frac{1}{2}$ oz., high into the vagina with a soft rubber catheter once or twice a day until healing is complete.

INTERPOSITION OF THE UTERUS

In this operation the fundus of the uterus is interposed between the bladder and the anterior vaginal wall.

Indications.

- (1) Cystocele.
- (2) Procidentia.

Contra-indications. This operation should never be performed :

- (1) Where there is the possibility of pregnancy following the operation.
- (2) If fibroids are present in the uterus.
- (3) In the presence of senile endometritis.
- (4) Where there is severe uterine hæmorrhage which might at a subsequent date necessitate hysterectomy.

Interposition of the Uterus for the Cure of Cystocele. This operation is indicated in elderly women with pronounced sacculation of the bladder and anterior vaginal wall when the sub-vesical fascia is very thin and all the tissues are atrophic, the advantages being that the operation is quickly and easily performed, there is a minimum of tension of the various sutures, and the results are usually very satisfactory as an excellent support is afforded for the bladder.

The method about to be described is of no value in the presence of second or third degree prolapse.

Procedure. The steps of the operation are identical with those of anterior colporrhaphy until the bladder has been separated from the front of the uterus and drawn upwards (fig. 1305). The utero-vesical pouch is then opened (fig. 1306), the cut edge of the peritoneum where it is reflected from the bladder is secured with a stitch, and the peritoneal cavity is explored through the opening (fig. 1307). The fundus of the uterus is tilted forwards with cat's-paw retractors (figs. 1308 and 1309), or by taking successive bites with two pairs of Allis forceps.

When the fundus has been delivered through the opening in the utero-vesical pouch (fig. 1310), the anterior free edge of the peritoneum is stitched to the back of the uterus near the cervix (fig. 1311). The

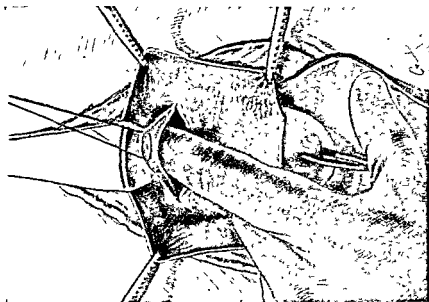


Fig. 1307.—INTRALIGAMENTARY DISSECTION OF THE UTERUS FOR CYSTOCELE. THE ANTERIOR VAGINAL WALL IS HELD OUT OF THE WAY WITH A NARROW RETRACTOR, AND THE PERITONEUM OF THE UTERINE POUCH IS REFLECTED NEAR ITS LOOSE REFLECTION FROM THE CERVIX, WHICH IS LIFTED UP, SNIPPED WITH SCISSORS, AND THE CAVITY OPENED.

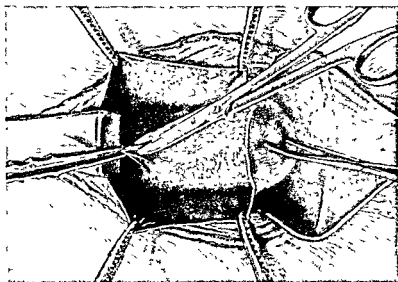


Fig. 1308.—INTRALIGAMENTARY DISSECTION OF THE UTERUS FOR CYSTOCELE. THE BLADDER IS HELD OUT OF THE WAY WITH A NARROW RETRACTOR, AND THE PERITONEUM OF THE UTERINE POUCH IS REFLECTED NEAR ITS LOOSE REFLECTION FROM THE CERVIX, WHICH IS LIFTED UP, SNIPPED WITH SCISSORS, AND THE CAVITY OPENED.

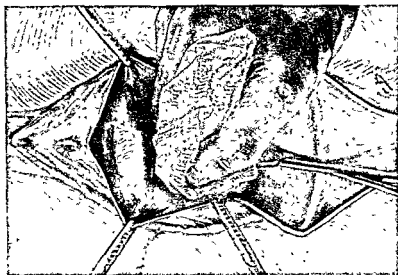


Fig. 1309.—INTRALIGAMENTARY DISSECTION OF THE UTERUS FOR CYSTOCELE. THE BLADDER IS HELD OUT OF THE WAY WITH A NARROW RETRACTOR, AND THE PERITONEUM OF THE UTERINE POUCH IS REFLECTED NEAR ITS LOOSE REFLECTION FROM THE CERVIX, WHICH IS LIFTED UP, SNIPPED WITH SCISSORS, AND THE CAVITY OPENED.

uterus is then anchored to the pubic arch by three catgut stitches, one passing through the aponeurosis of the pubic arch and through the back of the uterus near the cornu on each side, and one passing through



Fig. 1303.—INTERPOSITION OF THE UTERUS FOR CYSTOCELE.
CAT'S-PAW RETRACTOR.

the connective tissue on each side of the urethra and through the central part of the back of the fundus (fig. 1312).

The edges of the incision in the anterior vaginal wall are then approximated with interrupted catgut stitches which include a small bite of the fundus uteri (figs. 1313 and 1314).

Interposition of the Uterus in cases of Procidentia. The method about to be described should be employed when interposition of the uterus is indicated during the performance of an operation for the cure of procidentia.

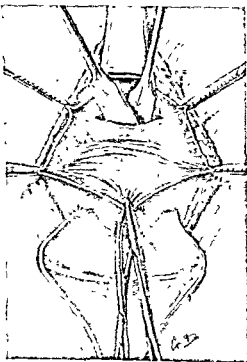


Fig. 1309.—INTERPOSITION OF THE UTERUS FOR CYSTOCELE. TWO CAT'S-PAW RETRACTORS ARE INSERTED AND THE FUNDUS UTERI IS BROUGHT FORWARD.

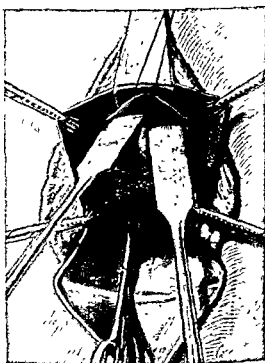


Fig. 1310.—INTERPOSITION OF THE UTERUS FOR CYSTOCELE. THE FUNDUS UTERI IS DRAWN THROUGH THE OPENING IN THE UTERO-VESELIC POUCH.

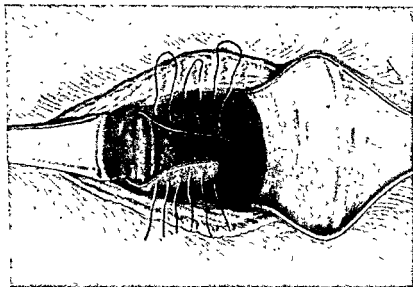


Fig. 1313.—INTERPOSITION OF THE UTERUS FOR CYSTOCELE. THE REMAINING PORTION OF THE VAGINA HAVING BEEN REMOVED, THE CUT EDGES ARE BROUGHT TOGETHER IN THE MID LINE WITH INTERRUPTED STITCHES.

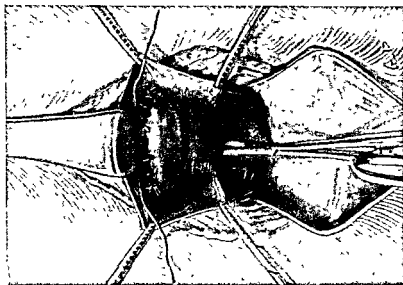


Fig. 1312.—[INTERPOSITION OF THE UTERUS FOR CYSTOCELE. THE POSTERIOR ASPECT OF THE FUNDUS IS STITCHED TO THE LIGAMENT OF THE PUBIC ARCH CLOSE TO THE URETHRA ON EACH SIDE AND ALSO LATERALLY. THIS ANCHORS THE FUNDUS AND AFFORDS A FIRM SUPPORT FOR THE NECK OF THE BLADDER AND THE URETHRA, PREVENTING THE LATISSIMUS FROM ROTATING FORWARDS UNDER THE SYMPHYSIS PUBIS.]

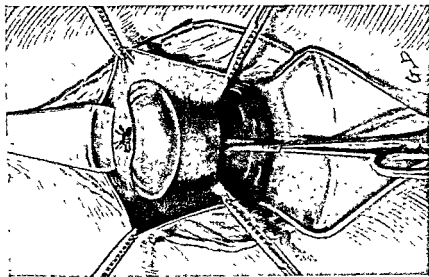


Fig. 1311.—INTERPOSITION OF THE UTERUS FOR CYSTOCELE. THE EDGES OF THE PERITONEUM IS SUTURED FROM THE BLADDER TO THE BACK OF THE UTERUS.

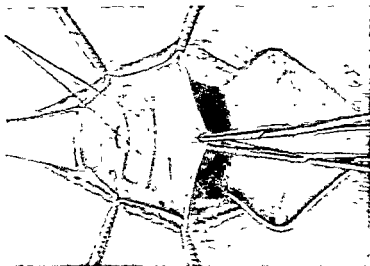


Fig. 110. Dissection of the Uterus and Prostate. The uterus is shown with a longitudinal incision and the prostate is visible below it. The dissection is made with the finger and the needle.

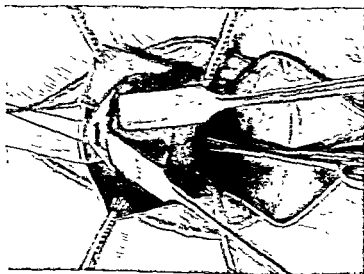


Fig. 111. Dissection of the Uterus and Prostate. The uterus is shown with a longitudinal incision and the prostate is visible below it. The dissection is made with the finger and the needle.

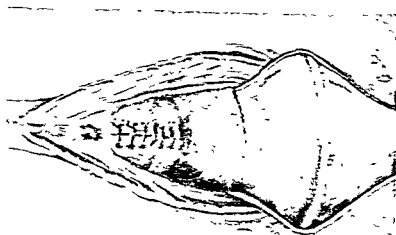


Fig. 112. Dissection of the Uterus and Prostate. The uterus is shown with a longitudinal incision and the prostate is visible below it. The dissection is made with the finger and the needle.

Advantages. In addition to the benefits of Fothergill's operation, a firm rigid support is afforded for the anterior vaginal wall.

Procedure. The steps of the operation are the same as those described under Fothergill's operation for prolapse up to the point where the bladder is separated from the front of the cervix.

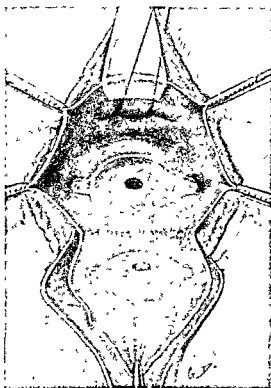


Fig. 1317.—INTERPOSITION OF THE UTERUS FOR PRO-
CIDENTIA. THE FUNDUS IS PUSHED BACK UNDER THE
BLADDER SO THAT THE CERVIX MAY BE BROUGHT FORWARD
AND BE AMPUTATED AFTER DISSECTING THE OUTLINED
FLAP OF VAGINAL WALL IN THE VAULT FROM THE
UNDERLYING CONNECTIVE TISSUES. THE CERVICAL AND
VAGINAL BRANCHES OF THE UTERINE ARTERY ARE
SECURED ON EACH SIDE.

The utero-vesical pouch is then opened, the fundus uteri is delivered through the opening (fig. 1315), and a long tractor stitch is passed through it (fig. 1316). The anterior edge of the peritoneal opening is stitched to the posterior aspect of the fundus. The fundus is then pushed back under the bladder as far as the anchoring stitch will allow, and the steps of the operation, including amputation of the cervix (fig. 1317) and suture of the cut vaginal wall of the vault to the cut end of the cervix, are completed posteriorly and laterally, as in Fothergill's operation.

By means of the long tractor stitch, the fundus is then drawn far

out and stitched to the pubic arch on each side of the urethra, as in the operation of interposition for cystocele (fig. 1318).

Suture of the vaginal wall to the cut end of the cervix and joining of the cut edges of the anterior vaginal wall are then completed (fig. 1319).

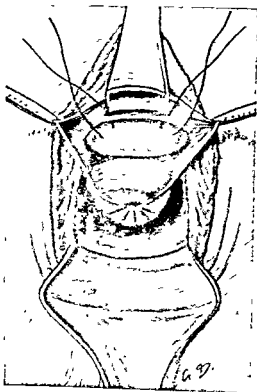


Fig. 1318.—INTERPOSITION OF THE UTERUS FOR PRO-CIDENTIA. THE CUT EDGE OF THE VAGINA IN THE VAULT IS SUTURED TO THE CUT END OF THE CERVIX ALL AROUND, AS DESCRIBED UNDER FOTHERGILL'S OPERATION. THIS SUTURING IS NOT COMPLETED ANTERIORLY. THE FUNDS IS DRAWN FORWARD AND IS STITCHED TO THE APONEUROSIS OF THE PUBIC ARCH.

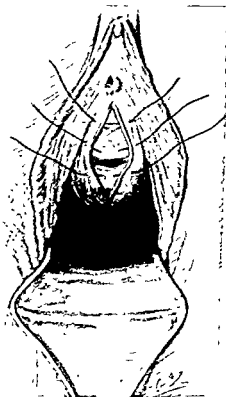


Fig. 1319.—INTERPOSITION OF THE UTERUS FOR PRO-CIDENTIA. SUTURE OF THE CUT EDGE OF THE VAGINAL WALL IN THE VAULT HAVING BEEN COMPLETED, THE DIVIDED EDGES OF THE VAGINA IN THE MID-LINE IN FRONT ARE APPROXIMATED WITH INTERRUPTED STITCHES, WHICH ALSO SECURE A HOLD ON THE INTERPOSED FUNDS AND SUPRA-VAGINAL CERVIX.

FORWARD SUSPENSION OF THE UTERUS BY VAGINAL ADVANCEMENT OF THE PERITONEUM

Indications. This operation is indicated for the correction of acquired retroversion of the uterus in women of child-bearing age.

Advantage. By this method an abdominal operation is avoided, as the procedure can be undertaken during the performance of an anterior colporrhaphy.

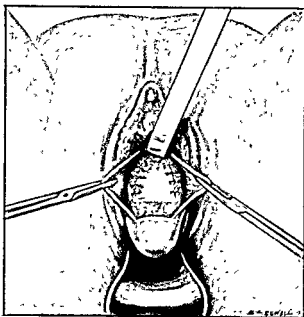


Fig. 1320.—FORWARD SUSPENSION OF THE UTERUS. THE ANTERIOR VAGINAL WALL HAS BEEN SEPARATED FROM THE BLADDER AND DIVIDED VERTICALLY IN THE MID LINE. THE BLADDER HAS BEEN STRIPPED OFF THE ANTERIOR ASPECT OF THE LOWER UTERINE SEGMENT, PUSHED UPWARDS, AND HELD IN AN ELEVATED POSITION BY THE NARROW VAGINAL RETRACTOR. THE PERITONEUM HAS BEEN DIVIDED ALONG THE LINE OF ITS LOOSE REFLECTION FROM THE FRONT OF THE UTERUS. THE ANTERIOR ASPECT OF THE UTERUS HAS BEEN DRAWN DOWNWARDS BY TAKING SUCCESSIVE BITES WITH ALLIS FORCEPS, WHILE AT THE SAME TIME THE UPPER CUT EDGE OF THE PERITONEUM HAS BEEN PUSHED UPWARDS AND STITCHED TO THE ANTERIOR ASPECT OF THE FUNDUS ALONG A SEMI-ELLIPTICAL LINE. THE OPERATION IS COMPLETED AS IN ANTERIOR COLPORRHAPHY.

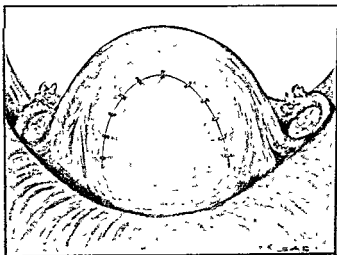


Fig. 1321.—FORWARD SUSPENSION OF THE UTERUS. ABDOMINAL VIEW OF THE ADVANCED FLAP OF PERITONEUM. THE ORIGINAL LINE OF REFLECTION OF THE PERITONEUM FROM THE FRONT OF THE UTERUS PASSED HORIZONTALLY ACROSS THE FRONT OF THE UTERUS AT THE EXTREMITIES OF THE SUTURE LINE.

Contra-indications. The operation is contra-indicated in the presence of chronic pelvic infection such as salpingitis, fibroids, or where the uterus cannot be brought forward easily by vaginal manipulation.

Procedure. The steps of the operation are identical with those of anterior colporrhaphy until the bladder has been separated from the front of the cervix and pushed upwards. At this stage the bladder is held up with a narrow retractor, and the peritoneum of the utero-vesical pouch is opened by a transverse incision of about $\frac{1}{2}$ inch wide.

The uterus is anteverted and the anterior surface of the fundus is drawn into this opening until the free edge of the peritoneum where it is reflected from the bladder is at the level of the insertion of the Fallopian tubes on the front of the uterus.

Here it is sutured by a series of interrupted catgut stitches, care being taken to leave no spaces through which omentum or bowel might prolapse (figs. 1320 and 1321).

The remaining steps of the operation are conducted in the manner described under Anterior Colporrhaphy.

OPERATIONS FOR NEW GROWTHS OF THE VAGINA

New growths of the vagina are :

- (1) Innocent—fibroma or fibromyoma.
- (2) Malignant—carcinoma, sarcoma, or chorionic carcinoma.

(1) *Fibromata* are very rare. They may be found as rounded swellings in the vaginal wall, or as pedunculated tumours.

Fibromata in the vaginal wall A finger is passed into the vagina and the position and size of the tumour are ascertained. In order to determine the exact anatomical relationships of the tumour, a finger is passed into the rectum if the tumour is in the posterior wall, or a sound is passed into the bladder if the growth is in the anterior wall.

When the growth is not too large it can be picked up with the fingers or Allis forceps, and long uterine forceps clamped behind it; this will put the overlying mucous membrane on the stretch, causing the tumour to bulge into the canal. The vaginal wall and the capsule are incised and the tumour is enucleated from its bed.

Before removing the clamping forceps, one or two mattress sutures are inserted to arrest bleeding and approximate the edges of the wound. When it is not possible to use the uterine forceps an incision is made over the tumour, the edges of the wound are retracted, the growth is picked up with tissue forceps, and traction is made upon it while enucleation is being effected. Bleeding vessels are secured and the edges of the wound are approximated with blanket stitches.

Pedunculated fibromata. An incision is made through the vaginal wall at the base of the pedicle which is then crushed and tied before the tumour is cut away, and the vaginal wound is closed with a mattress suture of catgut.

(2) *Malignant growths of the vagina.* Primary carcinoma and sarcoma of the vagina are very rare, especially the latter. Seldom are they seen at such an early stage that their removal is possible. Usually early invasion of the bladder, urethra, rectum or vaginal vault makes operation impossible. Should the growth be in an early stage and situated near the lower end of the vagina, it may be possible to excise it by partial colpectomy.

Procedure. The relations of the growth to the bladder are ascertained. Retractors are inserted and the growth exposed. When the vagina is narrow, a para-vaginal incision provides freer access. The growth is painted with a saturated solution of picric acid in absolute alcohol to harden its surface, to prevent pieces from breaking away, and to devitalize any fragments that may become detached. The growth is then widely excised, and the cut edges are sutured with interrupted or blanket catgut stitches.

When the growth is near the vulva the inguinal glands on both sides should be removed.

Chorionic carcinoma. Secondary growths, which are seen as small dark red nodules in the vaginal wall, should be removed by dissection when hysterectomy is performed for the primary growth.

RADICAL COLPO-HYSTERECTOMY

In this operation the vagina and uterus are removed through the vulva.

Indications. The chief indication is primary carcinoma of the vagina. On rare occasions it may be the operation of choice in cases of carcinoma of the cervix with secondary growths in the vagina, and in patients who are extremely fat or who have a colostomy wound or some condition of the skin which makes an incision into the abdomen hazardous.

The chief danger is loss of blood by extensive and free oozing which is not easily controlled in this operation. The bladder, rectum, colon, and especially the ureters, are liable to be injured, and there is considerable risk of sepsis in the long narrow passage which subsequently remains.

The difficulties are those of separating the vagina, isolating the ureters, and securing the main vessels, especially in the presence of formidable oozing.

Procedure. A circumferential incision is made around the entrance of the vagina. The cut edges are then steadied with Allis forceps in front, behind and laterally, and by snips and blunt dissection with scissors, together with gauze dissection, the vaginal wall is separated all round. The vaginal orifice is then closed by sutures which are left long to act as tractors.

The vagina is first pulled forwards, and, with swab dissection and a few sharp cuts directed against its taut wall, it is stripped from the rectum. Traction is then made backwards, and the bladder is peeled off its anterior aspect. Further traction is made from side to side and lateral separation is similarly effected.

When the vagina is moderately capacious an incision may be made through the perineal body down to the anal canal and the sphincter ani. When, however, the vagina is narrow, a *para-vaginal section* is necessary, by which method a deep incision is made in the left postero-lateral angle of the vaginal bed, starting 1 inch below the level of the cervix. It is carried downwards and backwards dividing the levator ani muscle and perineal body and passing round the rectum towards the coccyx. The rectum can then be retracted backwards and to one side, and wide access be thus obtained. Bleeding will be free. Individual vessels are caught and tied and oozing is arrested as far as possible by applying large swabs wrung out in hot saline.

An Auvard or a broad-bladed speculum is inserted into the new space and backward traction is made. The vagina is pulled forwards and the peritoneum of the recto-uterine pouch is picked up and opened with scissors. The opening is enlarged and the bowel is packed off with a large swab. The finger is then passed through the opening. Each utero-sacral ligament is identified, picked up with artery forceps and severed from the back of the uterus. A catgut ligature is passed around the severed end to assist identification when the peritoneal cavity is closed.

The vagina is next retracted backwards, and, by gauze pressure and occasional sharp dissection, the bladder is cleared from the front of the cervix and lower uterine segment, until the peritoneum is reached.

At this stage the ureters come into view and their exposure is further effected by separating the bladder on each side for a short distance. A broad vaginal retractor is used to pull the bladder forwards, and the utero-vesical reflection of the peritoneum is identified and opened. Another swab may then be passed through this opening to pack off the intestines.

The vagina being well retracted to the left and the bladder held forwards with a broad retractor, the right ureter is identified and separated from the para-cervical tissues. The index finger is passed behind the right broad ligament, and the uterine artery is identified by its pulsation and picked up with forceps. A suture is placed on the outer side of the forceps so that, when tied, it will include the uterine vessels, a portion of the cervico-pelvic ligament, and the lower portion of the broad ligament. These structures are then cut, thus freeing the uterus in this situation. This procedure is then repeated on the opposite side.

The fundus is drawn through the anterior opening by taking successive bites with Allis forceps; when brought into view under the bladder, it is grasped with a large vulsellum and drawn forwards, bringing the upper border of the broad ligament into view. The bladder being drawn well out of the way with a broad retractor and the fundus pulled downwards and to the right, the left tube and ovary are seized. The ovarian vessels on the same side are surrounded and tied with a double strand of No. 1 catgut, the ligature being tied as near as possible to the pelvic wall. A second ligature, passed a little to the inner side, further secures the vessels.

The round ligament is next identified and tied, and the uterus is cut free on this side by dividing the tissues medial to the ligatures. The same procedure is repeated on the opposite side, thus effecting complete removal of the uterus, vagina, tubes and ovaries.

After the swabs have been removed from the abdomen, the cut edges of peritoneum are sutured with closely-applied interrupted catgut stitches. During this process of suturing, the divided utero-sacral ligaments are secured, tied together, and incorporated in the peritoneal stitching, thus giving support to the bladder. If the cut ends of the cervico-pelvic ligaments can be made to meet in the mid-line, they also should be stitched together and to the ends of the utero-sacral ligaments.

Closure of the para-vaginal incision is carried out with a series of interrupted catgut stitches. The skin is partly closed and the raw cavity which remains is lightly packed with liquid paraffin and flavine (1 in 2000).

After Treatment. Efforts should be made to prevent contamination of the cavity until granulations are well formed. The first pack is removed in 24 hours, and a similar one soaked in liquid paraffin and flavine is inserted daily for the first week. Should there be sloughing of the tissues or infection, as evidenced by offensive discharge, the cavity is lightly packed with tampons of glycerine and flavine (1 in 2000) two or three times daily.

The bladder requires catheterisation every 6 hours for a week or ten days. After each catheterisation argyrol 5 per cent, 2 drachms, is instilled into the bladder. Urinary antiseptics, such as urotropin, are also prescribed.

Convalescence will be protracted and some pyrexia is almost inevitable. The epithelium from the skin around the entrance will grow into and line the cavity, so that when healing is complete a small narrow false vagina will be formed.

VAGINAL MANIPULATION FOR CORRECTION OF RETROVERSION OF THE UTERUS

The patient should first lie in the Sim's or left lateral position. A narrow-bladed retractor is then passed into the vagina, exposing the cervix, the anterior lip of which is grasped with a vulsellum (fig. 1322). The patient is then turned on her back and the speculum is removed.

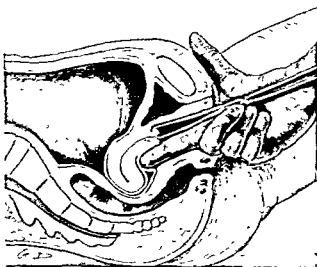


FIG. 1322.—VAGINAL MANIPULATION FOR CORRECTION OF RETROVERSION OF THE UTERUS. THE ANTERIOR LIP OF THE CERVIX IS PULLED DOWNWARDS WITH A VULSELLUM WHILE THE INDEX FINGER PASSES UPWARDS AND FORWARDS IN THE POSTERIOR FORNIX.

Manipulation. Downward traction is made on the vulsellum, one or two fingers are passed into the posterior fornix, and steady upward pressure is made on the back of the uterus, tilting the fundus forwards. The cervix is first pushed backwards and then upwards by means of the vulsellum, whilst the left hand is dipped deeply into the hypogastrium until the fingers press on the posterior surface of the fundus (figs. 1323 and 1324). The vulsellum is removed and the cervix is again pushed upwards and backwards, then upwards and forwards as

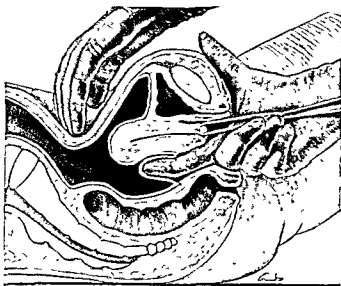


Fig. 1323.—VAGINAL MANIPULATION FOR CORRECTION OF RETROVERSION OF THE UTERUS. PRESSURE IS EXERTED WITH THE FINGER ON THE BACK OF THE UTERUS LIFTING FORWARD THE FUNDUS WHICH HAS NOW BEEN FREED FROM THE OVERHANGING PROMOTORY OF THE SACRUM.

the fundus is pressed towards the symphysis by the fingers on the abdomen. Undue force should be avoided, but firm pressure is usually required.

After the fundus has been restored to a forward position, the largest Hodge pessary compatible with the size of the vagina is inserted; this elevates and thrusts forward the posterior fornix, thereby maintaining

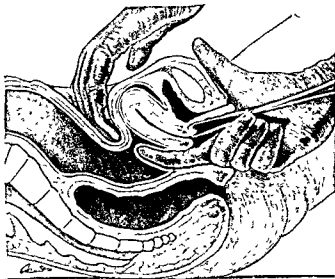


Fig. 1324.—VAGINAL MANIPULATION FOR CORRECTION OF RETROVERSION OF THE UTERUS. THE FUNDUS IS TILTED FORWARDS WITH THE FINGERS OF THE LEFT HAND AND BY MANIPULATION WITH BOTH HANDS THE UTERUS IS PULLED UPWARDS AND FORWARDS INTO THE CENTRAL POSITION.

the anteverted position of the uterus. The pessary should not be inserted unless the fundus comes forward freely and completely and remains there without undue tendency to retrovert.

A large ring pessary may be used when the perineal body has been split and the levatores ani muscles are too relaxed to hold the Hodge pessary.

After-Treatment. If the uterus is still subinvolved, copious hot douches should be given daily for two weeks. The patient should be examined a week later to determine whether or not the uterus has remained in the forward position; if so, the pessary is reinserted and left *in situ* for a month.

Correction is seldom permanent except where the condition follows labour, and where the manipulation has been undertaken within four to six weeks of delivery.

DILATATION OF THE CERVIX

Indications. Dilatation of the cervix is performed for the relief of primary dysmenorrhœa, for sterility, or as a preliminary to curettage of the uterus or to repair or amputation of the cervix.

Procedure. An Auvard speculum having been passed into the vagina to retract the perineal body and to keep the vaginal entrance open, the anterior lip of the cervix is steadied with a vulsellum and drawn downwards. The external os and as much of the cervical canal as possible are wiped dry with pledgets of gauze held in the tip of the uterine forceps and thoroughly painted with a saturated solution of picric acid in absolute alcohol (fig. 1325). A small swab should be placed in the posterior fornix to prevent the solution from coming in contact with the vaginal wall.

A uterine sound is then passed. This is usually an easy matter, but occasionally when there are cervical lacerations small pockets may be present which catch the point of the sound and prevent its entrance into the uterine cavity. Careful sounding in different positions will usually discover the canal. When the uterus is retroverted the concavity of the bend in the sound should be directed backwards. The length of the uterus is then estimated and the general outline of the walls and the cavity sounded to detect whether or not there is any bulging such as might be produced by a submucous fibroid. The presence of a septum or bicornuate uterus can also be detected by sounding.

The cervical dilators, lubricated with glycerine, are now passed in

series until the required size is reached, which is usually No. 12 Hegar. Counter-traction is made with the vulsellum as the dilators are being passed (figs. 1326 and 1327).

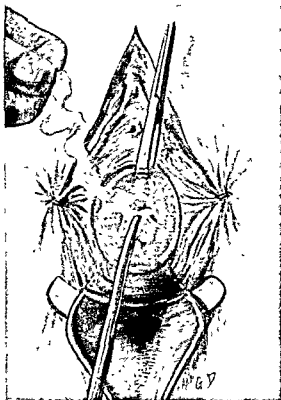


Fig. 1325.—DILATATION OF THE CERVIX. THE TOWELS HAVE BEEN STITCHED IN PLACE, AN AUVARD SPECULUM IS PASSED, AND THE CERVIX IS PULLED DOWNWARDS AND STEADIED WITH A VULSELLUM. A STRIP OF GAUZE HELD IN THE TIP OF THE UTERINE FORCEPS IS USED TO WIPE THE EXTERNAL OS AND CERVICAL CANAL CLEAR OF MUCUS. A SIMILAR STRIP SATURATED WITH 10 PER CENT PICRIC ACID IN ABSOLUTE ALCOHOL IS THEN APPLIED TO THE SAME SITE.

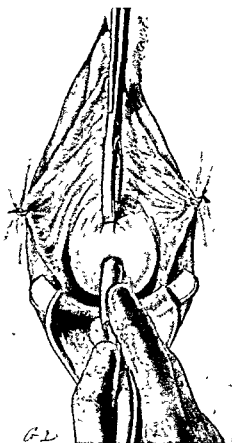


Fig. 1326.—DILATATION OF THE CERVIX. PASSING THE CERVICAL DILATORS. THE THUMB AND FIRST TWO FINGERS GRASP THE DILATOR WHICH IS PASSED THROUGH THE CANAL BY STEADY PRESSURE. AT THE SAME TIME, THE FOURTH AND FIFTH FINGERS ARE EXTENDED SO AS TO COME IN CONTACT WITH THE SPECULUM OR THE VULVA IN ORDER TO PREVENT THE DILATOR FROM BEING SUDDENLY THRUST FORWARD THROUGH THE UTERINE WALL.

Dangers. (1) } Laceration of the cervix.

(2) } Perforation of the uterus.

Both these injuries are much more common than is usually believed.

Laceration of the cervix. This is liable to occur when the cervix is dilated too rapidly or too widely, especially when there is fibrosis from chronic inflammation or when the cervix is undersized. The laceration usually takes place at the level of the internal os, on one or both sides of it. It should be suspected if the dilator suddenly slips

forward where the resistance has hitherto been firm, if the succeeding dilators pass too easily, or if the grip on the dilator by the cervix, felt as the instrument is being withdrawn, is lost.

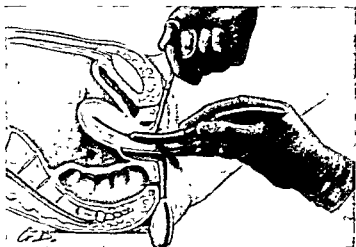


Fig. 1327.—DILATATION OF THE CERVIX. PROFILE VIEW. THIS SHOWS THE POSITION OF THE HAND GRASPING THE DILATOR AND THE THIRD AND FOURTH FINGERS EXTENDED TO PREVENT A SUDDEN FORWARD THRUST OF THE DILATOR WHICH MIGHT OCCUR IF THE CERVIX WERE LACERATED AND GAVE WAY UNEXPECTEDLY. THE CURVE OF THE DILATOR IS ALSO SHOWN FOLLOWING THE DIRECTION OF THE UTERINE CAVITY. COUNTER-PULL IS BEING MADE WITH A VULSELLUM ATTACHED TO THE ANTERIOR LIP OF THE CERVIX.

Perforation of the uterus. This is liable to occur when the uterus is sharply anteflexed or retroflexed, in which case the dilator may be pushed through the posterior or anterior wall. Occasionally, when a laceration of the cervix occurs suddenly, the dilator may unexpectedly slip forwards and be carried through the uterine wall. This is a comparatively rare mishap and can always be avoided if the surgeon places the fourth and fifth fingers against the vulva to steady the dilator and to prevent any precipitate forward movement of the hand.

TRACHELORRHAPHY

Trachelorrhaphy is an operation designed for suture of a cervical laceration.

cervix. These lacerations are most frequently bilateral, but may occasionally be unilateral or stellate. They are always attended by profuse discharge, which is at first comprised of clear mucus and later of muco-pus if there has been associated infection.

Contra-indications. Untreated acute or chronic infection, marked induration, or hypertrophy. A large and firm cervix should be amputated. Trachelorrhaphy is never performed if there is the least suspicion of carcinoma.

Procedure. The cervix is dilated. When the lacerations are bilateral the two lips of the cervix are approximated with vulsella so

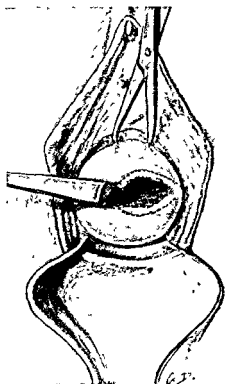


Fig. 1328.—TRACHELORRHAPHY. THE UNILATERAL LACERATED AREA IS EXCISED AS OUTLINED.

that the extent of the canal may be estimated. The lips are next separated, and the segment to be removed outlined and then dissected free with the scalpel (fig. 1328). The excision of this V-shaped segment removes the mucous membrane and tissues of the cervix to a depth of about $\frac{1}{4}$ inch on the opposing surfaces of the two lips, and at the bottom of the sulcus.

The denuded surfaces are then sutured with chromic catgut passed

through the entire thickness of both lips (fig. 1329). Three or four stitches, depending on the extent of the laceration, are inserted, the first being near the deepest part of the notch.

Much oozing and even free bleeding will occur from the denuded surfaces when the segment is removed, but suture of the wound will effectually arrest this. During the suturing a sound or a pair of uterine forceps is passed into the cervix to ensure that the canal is patent. Other lacerations are similarly treated.

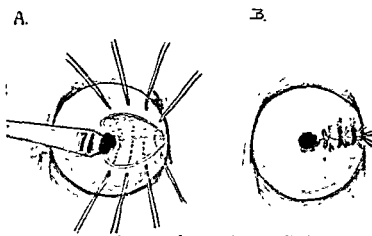


Fig. 1329.—TRACHELORRHAPHY. A. THE LACERATION HAS BEEN EXCISED AND INTERRUPTED STITCHES HAVE BEEN PASSED. B. SUTURES TIED.

As the result of early absorption of the sutures, suppuration of the wound, or insufficient denudation of the opposing surfaces, union sometimes fails to take place.

Secondary hæmorrhage is rare, but should it occur it is necessary to re-suture the area. When healing entirely fails on account of suppuration no further operation should be undertaken for at least three months, when amputation of the cervix will probably be required.

REDUCTION OF THE CERVICAL CANAL

This operation is indicated when the external os and the cervical canal are unduly dilated. The dilatation extends up to the internal os which, however, is always closed. The condition follows parturition and is almost invariably accompanied by profuse discharge.

Procedure. A segment is outlined and removed from one side of the cervical canal by sharp dissection (fig. 1330). This segment is

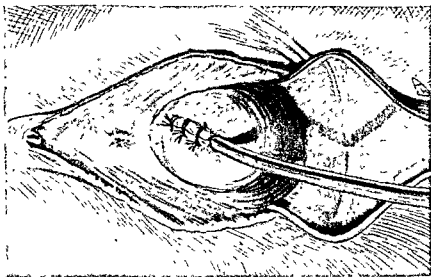


Fig. 1332.—REDUCTION OF THE CERVICAL CANAL. AS THE STITCHES ARE TIED THE CIRCUMFERENCE DIMINISHES AND THE CERVICAL CANAL IS REDUCED TO NORMAL DIMENSIONS.

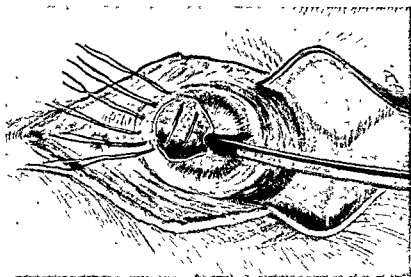


Fig. 1331.—REDUCTION OF THE (CERVICAL) CANAL. THE DENuded TRIANGLE IS UNDER RUN WITH CATGUT STITCHES WHICH ENTER AND EMERGE ON THE VAGINAL ASPECT OF THE CERVIX.

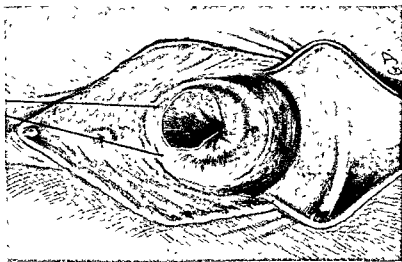


Fig. 1330.—REDUCTION OF THE CERVICAL CANAL. A TRIANGULAR SEGMENT, WITH ITS APEX AT THE INTERNAL OS AND ITS BASE AT THE EXTERNAL OS, HAS BEEN REMOVED FROM THE INSIDE OF THE CERVICAL CANAL.

V-shaped and extends from the margin of the cervix to the internal os. Its width depends upon the size of the canal and the amount of reduction required. The sides of the raw area are approximated with interrupted stitches of catgut (fig. 1331). These are passed through the anterior aspect of the cervix, and emerge at the posterior, traversing the canal medially to the edges of the raw area. A sound or a pair of uterine forceps should be passed into the cervix while the stitches are being inserted (fig. 1332). Free bleeding occurs, but is completely controlled by the sutures.

AMPUTATION OF THE CERVIX

By this operation the gland-bearing portion of the cervix is removed. Amputation of the cervix forms a part of the Fothergill type of operation for prolapse.

Indications. Congenital elongation, inflammation, enlargement or induration, cystic dilatation of the cervix, or pronounced leucorrhœa.

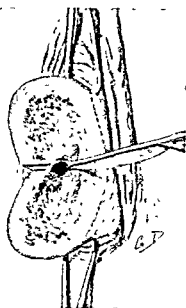


Fig. 1333.—AMPUTATION OF THE CERVIX. THE CERVIX IS VERY MUCH ENLARGED, BILATERALLY LACERATED, AND THE LIPS ARE EVERTED. THE CERVICAL CANAL, WHICH IS HERE REPRESENTED BY THE INTERNAL OS ONLY, HAS BEEN DILATED. THE DEEPEST PART OF THE CERVICAL LACERATION HAS BEEN INCISED TRANSVERSELY TO ENSURE THAT NO MUCOUS MEMBRANE IS LEFT IN THIS SITUATION.

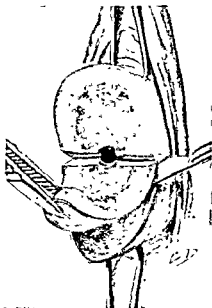


Fig. 1334.—AMPUTATION OF THE CERVIX. A POSTERIOR FLAP OF THE CERVIX IS FASHIONED BY REMOVING THE GREATER PART OF THE DEEP TISSUES OF THE POSTERIOR LIP OF THE CERVIX.

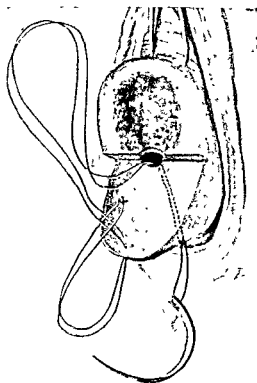


Fig. 1335.—AMPUTATION OF THE CERVIX. PASSING THE INFOLDING STITCH THROUGH THE NEW AND NOW THINNED-OUT POSTERIOR CERVICAL LIP.

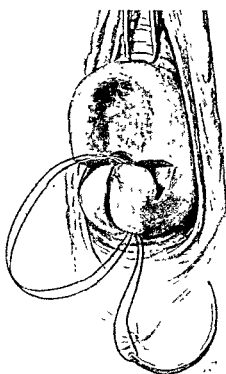


Fig. 1336.—AMPUTATION OF THE CERVIX. INFOLDING THE POSTERIOR LIP OF THE CERVIX SO THAT ITS EDGE IS BROUGHT IN CONTACT WITH THE FLOOR OF THE CERVICAL CANAL. THE INFOLDED LIP HAS BEEN FURTHER SECURED BY OVERSTITCHING WITH SEVERAL TURNS OF THE SUTURE.

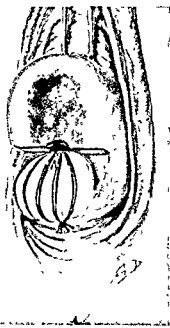


Fig. 1337.—AMPUTATION OF THE CERVIX. SEVERAL TURNS OF THE CATGUT STITCH ARE MADE, AND THE INFOLDED LIP IS COMPRESSED ON EACH SIDE OF THE MIDDLE LINE.

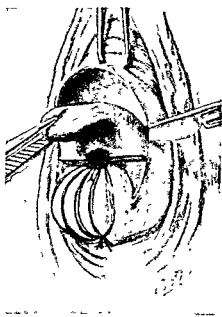


Fig. 1338.—AMPUTATION OF THE CERVIX. THE POSTERIOR LIP HAVING BEEN STITCHED INTO PLACE, THE NEW ANTERIOR LIP IS FASHIONED BY THE SAME PROCEDURE AS THAT EMPLOYED FOR FORMING THE POSTERIOR LIP.

Operation by Bonney's method. The cervix is dilated and curettage is performed if necessary.

A sound is passed into the bladder and its tip is palpated so as to gauge the lowest limit of the bladder. The cervix, having been pulled down by a vulsellum attached to the anterior lip, is split transversely to the level of the internal os (fig. 1333). The posterior lip is then converted into a thin flap by removing a half cone of its substance by a curved incision from side to side. The apex of the segment should reach up to and include the internal os. The flap is thin in the mid-line, concave from side to side, and gently sloping from the free edge towards the cervical canal (fig. 1334).

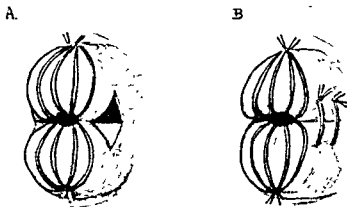


Fig. 1339.—AMPUTATION OF THE CERVIX. OPERATION COMPLETED. A. BOTH LIPS HAVE BEEN INFOLDED AND OVERSEWN. B. LATERAL STITCHES HAVE BEEN PASSED SO AS TO APPROXIMATE THE CUT EDGES OF THE CERVIX ON EACH SIDE AND TO OBLITERATE ALL DEAD SPACES.

A transfixion stitch of No. 2 20-day chromic catgut secures the free edge of the flap. The needle is passed about $\frac{1}{4}$ inch up the cervical canal and through the posterior wall (fig. 1335). In this way the suture emerges behind the cervix, so that when it is pulled taut, the flap is infolded against the margin of the canal (fig. 1336). The stitch is then brought over the flap and once more enters the canal, piercing the posterior wall lateral to the first turn of the stitch. This oversewing is repeated three or four times, thus compressing the flap tightly against the raw area (fig. 1337). The long end of the stitch is used as a tractor on the cervix while the anterior lip is being amputated.

The vulsellum is removed, a half cone of the substance of the anterior lip is excised, and a thin flap similar to the posterior one is fashioned. This is now infolded and oversewn (fig. 1338).

When the two flaps have been infolded, a raw space will remain on

each side of the cervix. Two stitches are passed deep through the cervical substance on each side lateral to the new-formed os; these, when tied, approximate the edges of the flaps and obliterate all dead spaces. An end of one of the stitches on each side is left long and tied, one to the anterior infolding stitch and the other to the posterior. These lateral interrupted stitches are very important, as they arrest hæmorrhage from the cut portion of the cervix and secure approximation of the two lips on each side of the new os.

On account of the free bleeding which will result, the posterior lip is removed first. Undue tension must be avoided in suturing, as subsequent swelling may cause the stitches to cut through the flaps, leaving ragged edges. The sutures should, however, always be sufficiently taut to arrest hæmorrhage.

The operation should never be performed in the presence of an acute attack of gonococcal cervicitis or an untreated chronic infection.

Hæmorrhage occurring between the 7th and 10th days is the most common complication, and is due to premature dissolution of the catgut by the cervical tissues. Unless bleeding is very free, an attempt should be made to control it by packing with bismuth gauze. When this fails, the cervix should be re-sutured as in the original operation.

REMOVAL OF THE GLAND-BEARING AREA OF THE CERVIX WITH THE DIATHERMY CUTTING CURRENT

(Ainsworth-Davis's technique)

Indications. This method may be indicated in chronic cervicitis with or without a cervical erosion, and in some cases of leucorrhœa due to excessive glandular activity in young women.

The eradication of cervical sepsis is important, as urinary tract infections are often associated with chronic cervicitis.

Technique. The cervix is dilated up to No. 8 Hegar and the uterus is curetted if necessary. A diathermy cutting current curette is passed through the cervical canal for a quarter of an inch beyond the internal os, the current is switched on, and a strip of endocervix is removed from the roof of the canal by slowly withdrawing the instrument.

By circumferential removal of a succession of such strips the whole of the gland-bearing area is excised.

Operation by Bonney's method. The cervix is dilated and is performed if necessary.

A sound is passed into the bladder and its tip is palpated gauge the lowest limit of the bladder. The cervix, having been held down by a vulsellum attached to the anterior lip, is split transverse to the level of the internal os (fig. 1333). The posterior lip is converted into a thin flap by removing a half cone of its substance by a curved incision from side to side. The apex of the segments thus formed reach up to and include the internal os. The flap is thin in the center and concave from side to side, and gently sloping from the free edge toward the cervical canal (fig. 1334).

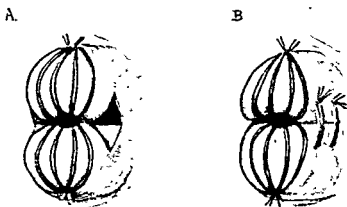


Fig. 1333.—AMPUTATION OF THE CERVIX. OPERATION COMPLETED. A. BOTH LIPS HAVE BEEN INFOLDED AND OVERSEWN. B. LATERAL STITCHES HAVE BEEN PASSED SO AS TO APPROXIMATE THE CUT EDGES OF THE CERVIX ON EACH SIDE AND TO OBLITERATE ALL DEAD SPACES.

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Technique. The cervix is dilated up to No. 8 Hegar and the uterus is curetted if necessary. A diathermy cutting current curette is passed through the cervical canal for a quarter of an inch beyond the internal os, the current is switched on, and a strip of endocervix is removed from the roof of the canal by slowly withdrawing the instrument.

By circumferential removal of a succession of such strips the whole of the gland-bearing area is excised.

Hæmorrhage is, as a rule, arrested by the cauterising effect of the cutting loop, but occasionally a small bleeding vessel near the external os requires sealing with the diathermy coagulating current applied with a ball electrode.

The uterine canal and endocervix are lightly packed with ribbon gauze soaked in 10 per cent picric acid in absolute alcohol, which is removed eight hours later. Saline douches are begun on the tenth day and healing is usually complete in two months.

A detailed account of this operation is given on page 2948.

REMOVAL OF CERVICAL POLYPI

(1) *Mucous Polypus.*

Procedure. A vaginal speculum is inserted, the cervix is steadied with a vulsellum, and the stalk of the polypus is twisted off with artery forceps. Its base is then scraped with a sharp scoop. When the attachment is wide it is snipped through with scissors close to the cervix, and the cervical canal is packed tightly with dry gauze for a few minutes to arrest oozing. If bleeding is persistent it must be controlled with a blanket stitch of catgut.

(2) *Fibromyomatous Polypus.*

Procedure. When the polypus is pedunculated the pedicle is twisted off with artery forceps. If the attachment is too thick to be torn through, it should be cut with scissors. If necessary, a stitch of catgut is passed through the base of the pedicle to arrest hæmorrhage. If the polypus remains inside the cervix, tightly filling the distended canal, and the pedicle is not accessible, the tumour should be pulled downwards with a vulsellum. It may occasionally be necessary to cut pieces from the fibroid to bring the pedicle into view, or the capsule may be incised and the fibroid enucleated from its bed.

After its removal the collapsed capsule is picked up with artery forceps, twisted tightly and cut through with scissors at its attachment.

On rare occasions the polypus may be so large as to fill the vagina. Such a growth should be grasped with a vulsellum, or a myomectomy screw inserted, and an attempt made to deliver it and expose the pedicle. Should this fail, the tumour must be cut away piecemeal until the pedicle can be reached and divided.

OPERATIONS WITHIN THE UTERINE CAVITY

CURETTAGE

Curettage is an operation whereby the walls of the uterine cavity are scraped.

Indications. (1) The operation is most commonly performed for diagnostic purposes when the possibility of malignant growth within the uterus is suspected.

(2) As a *therapeutic* measure curettage is employed for the removal of polypi or thickened endometrium. It may also relieve spasmodic or membranous dysmenorrhœa, and cure sterility and repeated abortion. Retained products may be removed with the curette, but only when it is certain that no active sepsis is present within the uterus.

Contra-indications. The chief contra-indication is endo-uterine sepsis, such as acute endometritis following abortion, septic retained products of conception, sloughing fibroid, or a myomatous polypus protruding through the cervix. Others include the presence of an acute cervicitis, a chronic untreated infection and chorionic carcinoma.

Exploratory curettage should not be practised if chorionic carcinoma is suspected, on account of the irregular bleeding which may follow the expulsion of a hydatidiform mole. The presence of actively growing chorionic cells can be demonstrated by the Aschheim-Zondek or Friedman test.

Procedure. The cervix is first dilated and a flat piece of gauze is then laid along the vaginal floor and pushed up behind the cervix so that all curetted fragments are deposited upon the gauze and can be removed for examination (fig. 1340). After the curette has been passed into the cavity as far as the fundus, it is firmly and evenly pressed against the wall and withdrawn. A strip of endometrium comes away with each stroke. The whole cavity is systematically scraped in this way, beginning with the anterior wall, proceeding laterally, and then across the posterior wall. The cornua should be carefully scraped with a small rounded curette to ensure that no

growth escapes detection. The scraping is continued until a firm grating sensation is felt with the curette, indicating that the uterine muscle has been reached (fig. 1341).

The strips of endometrium are squeezed between thick gauze to remove blood clot and permit of examination. Naked-eye inspection of the strips will, in the majority of cases, suffice to determine whether or not a malignant growth is present. Normal curettings are soft,

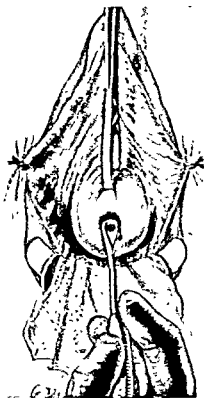


Fig 1340—CURETTAGE. A SWAB OF GAUZE IS LAID BEHIND THE CERVIX TO RECEIVE CURETTED MATERIAL FOR EXAMINATION.

shiny, and somewhat tough in texture; carcinomatous fragments are hard, granular and friable. An irrefutable diagnosis can, however, only be made on the microscopical findings.

At the completion of curetting, the vagina and external os are wiped dry, and the cavity of the uterus is packed with a strip of dry gauze for a few minutes to remove all blood. When the gauze is withdrawn, another strip soaked in a saturated solution of picric acid in absolute alcohol is inserted. The vagina is then lightly packed with a 6-inch roll of gauze and the two strips are tied together to ensure their both being removed together (fig. 1342).

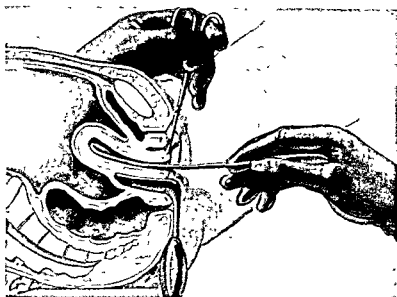


Fig. 1341.—CURETTAGE. SAGITTAL VIEW.

Dressings and After-Treatment. A sterile pad is applied. The two packings are removed after 12 hours, when an intramuscular injection of pituitrin, $\frac{1}{2}$ cc., and ergotamine tartarate (femergin), $\frac{1}{150}$ gr., is given. Extract ergot liq. (B.P. 1914), 40 minims, is given t.d.s. for 5-7 days.

Dangers. (1) Perforation of the uterus.

(2) Hæmorrhage.

(3) Sepsis.

(1) *Perforation of the Uterus.* Perforation of the uterus is undoubtedly a much more common accident than is generally supposed,

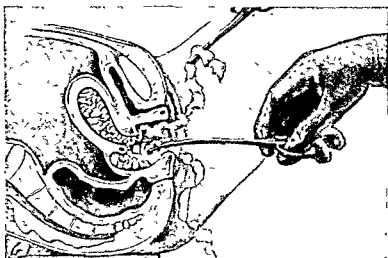


Fig. 1342.—CURETTAGE. SAGITTAL VIEW. PACKING THE UTERUS AND VAGINA.

and is very liable to occur unless great caution is exercised where there is a thin and soft uterine wall, as in cases of senile endometritis or carcinoma corporis. The wall is more likely to be perforated during dilatation than during curettage, especially if there is acute ante-flexion or retroflexion. The curette may also pass into and extend a tear initiated by the dilator, and this is particularly apt to occur in the lateral wall, extending the laceration into the broad ligament. The uterine cavity should be sounded before curetting, and where the presence of a perforation is suspected, it is better not to proceed with the operation.

Results of Perforation. In the majority of cases no untoward results occur. There are, however, certain possibilities such as the following:

- (a) Hæmorrhage: (i) into the peritoneal cavity.
(ii) into the broad ligament.
- (b) Prolapse of intestine.
- (c) Peritonitis.

Hæmorrhage into the peritoneal cavity. The symptoms and signs are those of shock and peritoneal irritation arising immediately after the accident; when the bleeding is profuse there will also be *air hunger* and *restlessness*. Symptoms of collapse will be manifest before the patient recovers from the anæsthetic; the pulse will be rapid, the skin cold and clammy, and the lips and conjunctivæ pale. As the effects of the anæsthetic wear off, there will be severe abdominal pain. Examination will reveal a resistant and very tender lower abdomen. Ordinarily, after curettage there is no pain and only negligible tenderness; hence these symptoms are important guides and demand immediate abdominal exploration.

Treatment. The abdomen is opened and the rent in the uterus is closed with catgut sutures, after which the effused blood is removed. On very rare occasions the laceration may be so extensive as to indicate removal of the uterus.

Hæmorrhage into the broad ligament results from laceration at the internal os during dilatation of the cervix. When the tear extends into the broad ligament, the curette may be passed into this opening instead of into the uterine cavity, injuring the branches of the uterine artery or the main vessel itself, and thus increasing the hæmorrhage.

With this type of injury external bleeding may be trivial, while effusion between the layers of the broad ligament is often considerable, forming a hæmatoma, which may spread widely behind the peritoneum, or even into the loin.

With an extensive extravasation there is severe pain, rapid pulse and pallor. A swelling, very tender on palpation and dull on percussion, may appear above Poupart's ligament and along the side wall of the pelvis. Marked intestinal distension may also be present, but this is rare.

When the effusion is slight there will be some degree of pelvic pain and a palpable swelling on one side of the uterus.

Treatment. When a cervical laceration is felt the vaginal portion of the cervix should be split up to the vault so as to expose it. Deep mattress sutures are then passed to control the bleeding vessels. Should this fail, and provided that the vagina is sufficiently capacious, the base of the broad ligament may be opened up from below and the vessels secured. If this is impossible the vagina should be tightly packed, the abdomen opened, the ureter identified, and the uterine artery tied from above.

Where the effusion in the broad ligaments is extensive, the abdomen should be opened, the blood clot removed, the bleeding point secured, or the uterine artery itself tied on both sides of the laceration. The opening in the cervix should also be sutured. Saline infusion may be given at the end of the operation in order to combat shock and the effects of hæmorrhage.

Prolapse of intestine through a laceration is very uncommon, but should it occur there is danger of the bowel being further damaged. When such an accident is suspected or is known to have occurred, *no attempt whatever should be made to replace the prolapsed bowel into the abdominal cavity or to pack the uterus.* The abdomen should be opened immediately and the loop of bowel withdrawn and carefully examined. If uninjured, it is cleansed, but if injured or gangrenous the involved portion must be resected and the continuity of the bowel restored by end-to-end anastomosis. The rent in the uterus is then closed with deep sutures.

Peritonitis. When there is sepsis inside the uterus, peritonitis may occur after perforation. It may arise early due to organisms being carried directly into the peritoneal cavity, or late as the result

of suppuration of a pelvic hæmatocele. Symptoms of peritonitis manifest themselves from 12 to 24 hours after the operation, in contrast to the symptoms of hæmorrhage which arise *immediately* after the operation. This is a point of considerable differential diagnostic value.

Severe immediate peritonitis may result from the escape of irritating fluids through a rent in the uterus. It is safer not to douche the uterus when performing curettage.

Treatment. When the symptoms and signs of peritonitis are mild, the patient is placed in the Fowler position and carefully watched. If no improvement follows or if the symptoms are pronounced, drainage of the peritoneal cavity must be instituted without delay. In severe cases a local anæsthetic is employed and a small opening is made in the hypogastrium and a large rubber drainage-tube with a wick of gauze is inserted to the bottom of the pouch of Douglas. This may be undertaken with the patient in bed.

(2) *Hæmorrhage.* Sometimes there is very free bleeding after curettage, especially when the operation is performed for retained products or where there is a submucous fibroid the capsule of which has been injured. The presence of a fibroid should be detected by the curette passing over its rounded prominence. Hæmorrhage from either of these causes is best arrested by packing the uterus and the vagina, and this is always an effectual measure unless there is extensive laceration. Intra-uterine douches are quite useless for the purpose of arresting hæmorrhage.

(3) *Sepsis* is the greatest of all dangers. It may arise :

- (a) From infection introduced at operation ; or
- (b) By the spread of infection already present in the uterine cavity, as in septic abortion.

The introduction of sepsis can be prevented by correct technique.

Curettage should not be performed if sepsis is already present inside the uterus. Cases of septic abortion must be kept under observation and, if febrile, given intra-uterine injections of glycerine. No attempt should be made to empty the uterus until the temperature has been normal for several days or even weeks.

Results of sepsis following curettage :

- (i) Acute salpingitis with pelvic peritonitis spreading to the general peritoneal cavity.
- (ii) Pelvic cellulitis.
- (iii) Thrombophlebitis.
- (iv) Septicæmia.

REMOVAL OF PRODUCTS OF CONCEPTION

Contra-indications. The presence of sepsis is a definite contra-indication. *Should the patient have any degree of pyrexia, foul discharge, or tenderness in the pelvis, no attempt should be made, even digitally, to remove retained membranes.* If there is a suspicion that sepsis has been introduced in an attempt to procure abortion, operation should be delayed for a week or more, even if the patient is afebrile.

Procedure. The cervical canal is wiped dry, swabbed with 10 per cent picric acid in absolute alcohol, and then dilated up to No. 18 Fenton—a size which will admit the finger. The vagina and cervix are then swabbed dry and again painted with 3 per cent picric acid in rectified spirit. A finger is dipped in the picric acid solution and passed into the cervical canal, while counter-pressure is made on the fundus with the other hand over the hypogastrium. The cavity is then explored and all portions of membrane are peeled off the uterine wall. Ring forceps are passed into the uterus and detached fragments removed. The procedure is repeated until the cavity is clear, the uterus and vagina then being packed.

Dangers. The outstanding danger is sepsis ; others are described under “Curettage” (see page 2465). If sepsis is already present in the uterus it may spread and lead to endometritis, salpingitis, pelvic peritonitis, pelvic cellulitis, or even septicæmia.

Curettage. The question of curetting for the removal of retained products is a subject upon which there is much difference of opinion. I consider that the curette should not be used to remove retained products until several days or even weeks have elapsed after abortion, when

there is no sepsis present, and when the patient has been free from fever and foul discharge for a considerable time.

Dressings and After-Treatment. The two packs—uterine and vaginal—are removed after 24 hours. At the time of removal an intramuscular injection of pituitrin, 1 cc., and ergotamine tartarate, $1\frac{1}{16}$ gr., is given. Uterine contractions are maintained and involution encouraged by giving extract ergot. liq., 40 minims, t.d.s., or ergometrine, 0.5 gm., t.d.s.

REMOVAL OF UTERINE POLYPI

Uterine polypi may be :

- (1) Adenomatous.
- (2) Myomatous.
- (3) Placental.

(1) *Adenomatous polypi of the uterine body* are usually discovered during exploratory curettage of the uterus. Occasionally they can be felt attached to the uterine wall and interfering with free movement of the curette over the inner surface of the cavity. Firm application of the curette will almost invariably detach them; where difficulty is experienced a sharp scoop should be used.

(2) *Myomatous polypi of the uterine body.* The following conditions may be found :

(a) *A polypus with a long pedicle.* If the fibroid has already been extruded through the external os and the stalk is accessible, the latter is cut through. In this type of case the fibroid is certain to be infected and organisms will be present in the pedicle and in the uterine cavity. If curettage is performed immediately after removal of the polypus, it is liable to be followed by septic endometritis, and not infrequently by acute salpingitis, pelvic peritonitis or pelvic cellulitis. It is better in such cases to pack the uterus and postpone further exploration for at least three weeks.

(b) *A fibroid polypus which has not dilated the cervix.* The polypus is usually discovered during exploration of the uterus with the curette or uterine sound. The cervix is dilated and the polypus seized with a vulsellum and its pedicle twisted free. When the latter is too large or

strong to permit of removal in this way, an attempt should be made to divide it with scissors. When both these methods fail, anterior hysterotomy should be performed. The fibroid may be cut away piecemeal or possibly removed whole, and the pedicle crushed with artery forceps and severed. Bleeding usually ceases spontaneously, but should it continue it must be controlled by a mattress stitch.

(c) *A polypus partially protruding from the cervical canal.* Before operation is undertaken the condition must be distinguished from chronic inversion of the uterus, in which condition the uterus is absent from its usual position, the crater of the inversion can generally be felt, and on passing the sound the uterine cavity is found to be shortened. The inverted fundus bleeds easily on being rubbed. When it protrudes sufficiently far through the external os the uterine openings of the Fallopian tubes on each side may sometimes be seen.

Procedure. The polypus is drawn through the canal with a vulsellum. If the pedicle can be reached it is cut through. When, however, this is impossible, the polypus is removed in pieces until the remnant can be stripped from its capsule. This is then twisted, crushed and divided.

(d) *Partial inversion of the uterus with a sessile submucous myoma.* Occasionally the fundus may be partially inverted as the result of the downward pull of a fibroid polypus in process of extrusion through the os.

Procedure. The capsule is incised and the tumour stripped from its bed and removed. The attenuated capsule is then trimmed away, the fundus pressed back, and the uterus packed.

(3) *Placental polypus.* When this type of polypus is suspected, the cervix should either be dilated sufficiently for a finger to be inserted with which to detach the polypoid mass, or failing this the polypus should be removed with a sharp curette.

Dressings and After-Treatment. In all these cases the vagina and cervix are thoroughly dried. The uterus is temporarily plugged with gauze in order to remove all blood and clots, and is then packed with gauze soaked in a saturated solution of picric acid in absolute alcohol, which is a powerful antiseptic and hæmostatic. The vagina is packed with a 6-inch roll of gauze soaked in paraffin and flavine (1 in 2000).

1 cc. of pituitrin and ergometrine, 0.25 mgm., is injected intramuscularly. The packs are removed in 12 hours, when the injection is repeated. Extract ergot liq. (B.P. 1914), 40 minims, t.d.s., should also be prescribed.

VAGINAL REMOVAL OF SUBMUCOUS MYOMATA

Indications. Vaginal removal of submucous fibroids is indicated when such tumours are discovered during exploration of the uterus.

Contra-indication. The presence of interstitial or subserous fibroids.

Routes of approach :

(1) Through the dilated cervix.

(2) Through an anterior vaginal hysterotomy.

In either case the fibroids may be removed by enucleation or by morcellation.

(1) *Removal through the Dilated Cervix. Procedure.* Through the dilated cervix a finger is inserted into the uterus and the outline of the tumour and its exact position are defined. A pair of scissors or a scalpel is then passed alongside the finger and an incision made over the tumour so as to divide the overlying capsule. The opening of the capsule is enlarged with the points of a pair of scissors or a pair of uterine forceps. The uterus is then steadied by the left hand pressing into the hypogastrium, a finger is inserted through the opening, and the tumour is enucleated from its bed. When the tumour is too large to be delivered through the cervix it should be cut away in small pieces.

(2) *Removal after Vaginal Hysterotomy.* Where there are one or two submucous myomata which cannot be reached through the dilated cervix, these may be removed per vaginam after the performance of a vaginal hysterotomy.

Procedure. The cervix and anterior uterine wall having been incised, the tumour may be either enucleated or removed piecemeal. The capsule can frequently be clamped and tied after the fibroid has been extirpated, the incisions in the uterus, cervix and the anterior vaginal wall then being sutured as described under "Hysterotomy."

Difficulties. (a) *Adherence to the capsule.* When the tumour cannot be stripped easily from its bed, it should be seized with a vulsellum

and steady traction made in different directions, while at the same time an attempt is made to free it by means of the finger and scissors.

(b) *Large size of the tumour.* Tumours over 3 inches in diameter should be removed by the abdominal route.

(c) *Endometriomata (Adenomyomata).* These tumours may easily be mistaken for submucous fibroids, as they grow under the mucosa and give rise to similar symptoms. As they are not encapsuled, enucleation is impossible. An incision into the growth will reveal a hard dense mass without any differentiation between the capsule and the tumour. Where bleeding is free, the vagina should be tightly packed and abdominal hysterectomy performed.

Dangers. See dangers of "Curettage" (page 2467).

VAGINAL HYSTEROTOMY

Vaginal hysterotomy is the operation whereby the cervix and uterus are divided anteriorly as high as the peritoneal reflection.

Indications. The operation is usually performed for the purpose of exploration of the uterus, removing submucous fibroids, and effecting rapid vaginal delivery. The last-named procedure has been called vaginal Cæsarean section, but the term Cæsarean section should be reserved for the abdominal operation only.

Procedure. An Auvard speculum having been inserted into the vagina, the cervix is pulled downwards with a large vulsellum, and an incision is made across the vagina close to its attachment to the front of the cervix. The edge of the vaginal wall is picked up with two pairs of Allis forceps and retracted upwards, and the line of reflection of the bladder is identified and freed with scissors until the plane of separation is opened. The bladder is now stripped off the front of the cervix and uterus up to the loose peritoneal reflection with gauze pressure aided by snips of the scissors. A narrow-bladed retractor is inserted and the bladder is drawn upwards.

A vulsellum is placed on the anterior lip of the cervix on each side of the middle line; the cervix and lower uterine segment are now divided with a pair of straight scissors up the centre as high as the

utero-vesical reflection. When the cavity is opened, delivery of the contents of the uterus can be effected.

The vulsella, if previously removed, are now re-attached to the cervix on each side of the incision, the narrow-bladed retractor holding the bladder upwards as the cervix is pulled downwards. Beginning at the upper end of the incision, the divided edges of the uterus are united with interrupted stitches of doubled No. 1 catgut. These stitches penetrate the muscle but emerge through the incised tissue so as not to include the mucous membrane. The vaginal incision is closed transversely by a continuous suture.

CHAPTER IV

ABDOMINAL GYNÆCOLOGICAL OPERATIONS

HYSTERECTOMY

HYSTERECTOMY is the operation for removal of the uterus.

(A) ABDOMINAL

(1) *Sub-total Hysterectomy*. Only the body of the uterus is removed the cervix being left in its normal position.

(2) *Total Hysterectomy (Panhysterectomy)*. The body and cervix of the uterus are both removed.

(3) *Radical Hystero-Colpectomy (Wertheim's operation)*. The uterus is removed in its entirety, together with a variable portion of the vagina.

(B) VAGINAL

(1) *Vaginal Hysterectomy*. In this operation the cervix and uterine body are removed.

(2) *Radical Colpo-Hysterectomy*. The vagina, uterus and cervix are removed.

INDICATIONS FOR OPERATION

(a) *Congenital abnormality*—hæmatometra.

(b) *Acquired abnormalities*—functional hæmorrhage (metropathia hæmorrhagica), inversion, acquired hæmatometra and dysmenorrhœa.

(c) *Injuries*—(i) operative; (ii) obstetrical; (iii) by external violence.

(d) *Inflammations*—sepsis (rare cases), senile endometritis and tuberculous endometritis.

(e) *New growths*—

- (i) *Innocent*: fibromyoma and endometrioma (adenomyoma).
- (ii) *Malignant*: carcinoma, chorionic carcinoma and sarcoma.

(a) *Congenital abnormality*. Hæmatometra, due to complete or partial absence of the vagina, will call for hysterectomy unless the obstruction can be removed or an artificial vagina fashioned to provide a means of escape for menstrual fluid. Menses may accumulate in one half of a double uterus as the result of atresia of its outlet, or pregnancy may take place in a rudimentary uterine horn. In either case removal of the affected part is indicated.

(b) *Acquired abnormalities*. When uterine hæmorrhage due to functional disorder—metropathia hæmorrhagica—has defied all palliative measures and is undermining the health and even threatening the life of the patient, hysterectomy will be necessary.

Acquired atresia of the genital tract, such as that resulting from cicatricial contraction following amputation of the cervix (possibly complicated by suppuration); dysmenorrhœa unrelieved by medicinal, endocrine, or minor operative measures; and chronic inversion of the uterus when restoration by other means have failed, are indications for removal of the uterus.

(c) *Injuries*.

- (i) *Operative*. These usually occur during the operation of dilatation and curettage.
- (ii) *Obstetrical*. Rupture of the uterus which cannot be satisfactorily sutured nor the hæmorrhage controlled is more safely treated by hysterectomy, which will prevent the possibility of further bleeding or septic endometritis. Should there be prolapse of bowel or omentum through the rent in the uterus, or symptoms of intra-peritoneal hæmorrhage, radical operation must be undertaken without delay.
- (iii) *By external violence*. Although perforation of the uterus most commonly occurs during an attempt to produce abortion, it may also be caused by a fall, gunshot wound, stab, etc.

(d) *Inflammations.* An infected, sloughing fibroid demands hysterectomy.

Chronic gonococcal or septic infections which give rise to a very irritating discharge, causing excoriation of the vulva and the skin of the peri-anal region, groins and inter-natal cleft, are best treated by hysterectomy if all other measures for alleviation have failed. Here the uterus is not only a focus of infection, but may frequently be the source of profuse hæmorrhage; again, it is of little functional value, the tubes in a large percentage of cases having been previously excised.

Senile endometritis and pyometra, unrelieved by dilatation, swabbing with antiseptics, drainage or glycerine injections, demand hysterectomy. Tuberculous endometritis, a rare affection of the uterus and one simulating carcinoma from which it can be differentiated only by microscopical examination of curetted material, should be treated by hysterectomy after the possibility of generalised tuberculosis has been excluded.

(e) *New Growths.*

- (i) *Innocent.* Hysterectomy should always be performed for *fibromyomata* when these tumours are suppurating, sloughing, softening, or have become affected by sarcomatous change or carcinomatous invasion. Great size or multiplicity of the tumours is not necessarily an indication for hysterectomy. If the patient is young the tumour or tumours should be enucleated where possible, but when fibroids occur in women after the menopause in the presence of chronic infection, laceration of the cervix, or marked cervical discharge, hysterectomy should be advised.

Endometriomata (adenomyomata) are not encapsulated and therefore cannot be enucleated. When causing hæmorrhage, pain or discomfort, hysterectomy is usually necessary.

- (ii) *Malignant New Growths.* Total hysterectomy is the operation of choice and should always be performed when the uterus is removable. Carcinoma of the cervix calls for radical hysterocolpectomy.

Certain conditions which affect the Fallopian tubes are indications for hysterectomy.

(a) *Tubal Pregnancy.* In any of the three following conditions hysterectomy may be necessary in order to control hæmorrhage :

- (i) Where pregnancy occurs in the interstitial portion of the tube. In such cases laceration of the uterus may be so extensive that hæmorrhage cannot be controlled by any other means.
- (ii) Where in cases of early secondary intra-peritoneal pregnancy the gestation sac is attached to the back of the uterus.
- (iii) Where in late cases of intra-peritoneal or intra-ligamentous gestation the placenta is wholly or partially adherent to the uterus.

In the two latter conditions separation of the placental attachments will be attended by copious hæmorrhage which can only be controlled by excising the uterus.

(b) *Carcinoma of the tube* is one of the rarest new growths of the genitalia. For this condition both tubes and ovaries must be removed, together with the uterus.

Conditions which may affect the ovary. Malignant disease of the ovary necessitates removal of the uterus, together with both tubes and ovaries.

Myomata and cysts of the broad ligament may be so adherent to the uterus that hysterectomy is required in order to control hæmorrhage.

SHOULD THE FALLOPIAN TUBES AND THE OVARIES BE REMOVED WHEN HYSTERECTOMY IS PERFORMED ?

The *Fallopian tubes* are of no value after the performance of hysterectomy, and they should *in all cases* be removed as there is no advantage in preserving them.

General opinion is in favour of conserving the *ovaries* when the uterus is removed for non-malignant conditions, the assumption being that the symptoms of an artificial menopause are prevented or at least alleviated by so doing. This view is queried by Beckwith Whitehouse (*Canad. Med. Assn. J.*, p. 585, Dec 1933), and also by Wilson, Donald. Phillips, Novak, Culbertson and Graves.

The following is a résumé of their views :

When removal of the uterus is necessary the symptoms of the menopause :

- (a) May not be avoided by conserving the ovaries ;
- (b) Are often diminished when the ovaries are excised ;
- (c) Are frequently less pronounced when the ovaries are not removed in *young* patients ;
- (d) Are more marked the nearer the time of operation approaches to the natural age of the menopause.

It is further stated that conservation of the ovaries may actually be harmful in cases where hysterectomy is necessary.

It is important, however, that the patient *should not know* that her ovaries have been excised.

TOTAL ABDOMINAL HYSTERECTOMY

Indications (see page 2477).

Contra-indications. Acute or sub-acute septic salpingitis. When, on account of severe uterine bleeding, removal of the uterus is necessary in addition to excision of the tubes, and possibly also the ovaries, the sub-total operation is to be preferred as the total procedure opens up wide areas to infection.

Difficulties and disadvantages are virtually the reverse of those cited under sub-total hysterectomy. A special advantage of the total operation about to be described is the tightening and joining of the cervico-pelvic and utero-sacral ligaments, thus affording a strong support for the vaginal vault, and, in addition, a cure for utero-vaginal prolapse of the first degree when present.

The following procedure is the one usually employed for removal of the uterus, except when there is malignant disease, when the deeper parts of the pelvis are inaccessible as the result of a myoma of the cervix or of a broad ligament, or when the uterus is retroverted and fixed by extensive adhesions, in which case other operative procedures, which are about to be described, are preferable.

Special Pre-operative Preparation. The vulva is painted with antiseptic solution, the bladder is emptied, and the vagina is firmly

packed with a 6-inch roll of gauze soaked in the antiseptic solution. The end of the strip is left hanging over the side of the table so that the pack may be withdrawn at the appropriate time.

Procedure. The abdominal cavity is opened by a right paramedian incision, the wound edges are covered and retracted, and the operation area is packed off with soft turkish towels wrung out in warm normal saline solution.

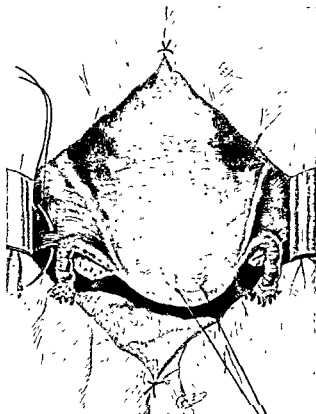


Fig. 1343.—TOTAL ABDOMINAL HYSTERECTOMY. THE UTERUS IS PULLED UPWARDS AND TO THE RIGHT WITH A LONG TRACTOR STITCH. THE OVARIAN VESSELS IN THE OVARIO-PELVIC LIGAMENT ARE UNDERRUN WITH CATGUT AND TIED.

The uterus is drawn upwards and to the right with a vulsellum or tractor stitch (fig. 1343). A needle carrying No. 1 catgut is passed through the left broad ligament immediately to the inner side of the ovary and tied, thereby securing the ovarian vessels. A second stitch, which secures the round ligament also, is passed near the first stitch. A similar procedure is then carried out on the right side. When, however, the tubes and ovaries also are to be removed the ovario-pelvic ligaments are pierced and tied and then secured to the round ligament

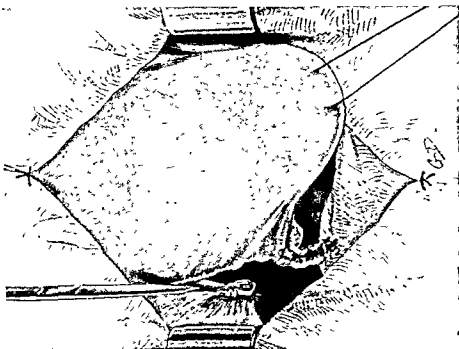


Fig. 1345.—TOTAL ABDOMINAL HYSTERECTOMY. THE UTERUS IS PULLED FORWARD AND TO THE RIGHT. THE BROAD LIGAMENT IS DIVIDED DOWN TO ITS BASE, THE ROUND AND OVARIO-PELVIC LIGAMENTS BEING CUT MEDIAL TO THE LIGATURES.

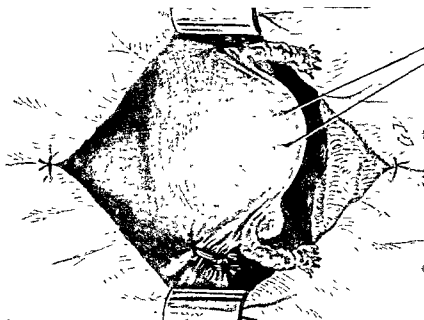


Fig. 1346.—TOTAL ABDOMINAL HYSTERECTOMY. THE ROUND AND OVARIO PELVIC LIGAMENTS ARE TIED TOGETHER AFTER THE LATTER HAVE BEEN INDIVIDUALLY LIGATED.

as described above (fig. 1344). This method of ligation has the object of doubly securing the vessels and of fixing the round ligament to the broad or ovario-pelvic ligament as the case may be, so as to facilitate reperitonisation of the pelvis at the end of the operation. The round and broad ligaments are cut about $\frac{1}{2}$ inch medial to the two ligatures on each side, and each broad ligament is then divided down to its base (fig. 1345).

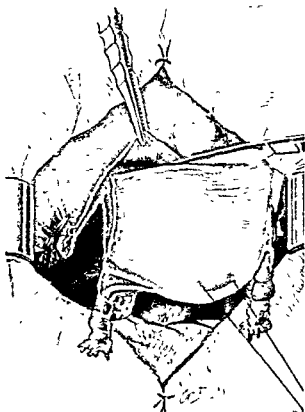


Fig. 1345.—TOTAL ABDOMINAL HYSTERECTOMY. THE LOOSE REFLECTION OF PERITONEUM FROM THE FRONT OF THE UTERUS IS CUT TRANSVERSELY AFTER THE TWO BROAD LIGAMENTS HAVE BEEN DIVIDED.

Free bleeding which occurs from the large vessels in the medial or uterine part of the divided broad ligament is arrested by pressure with the fingers until the uterine vessels are secured by applying a pair of artery forceps horizontally at the level of the internal os, the points of these being firmly pressed against the sides of the cervix. The peritoneum at the line of loose reflection from the front of the uterus on to the bladder is next divided transversely, joining the incisions in the broad ligaments (fig. 1346).

The bladder is stripped off the front of the cervix and the upper part

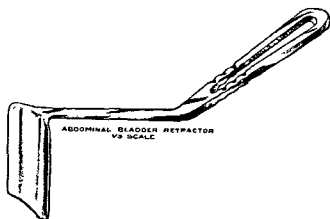


Fig. 1347.—ABDOMINAL BLADDER RETRACTOR.

of the vagina with gauze dissection, the special retractor is inserted, and the bladder is drawn towards the symphysis (figs. 1347 and 1348).

The uterus is pulled upwards and to one side, the uterine vessels and surrounding tissues are divided with a scalpel, and the incision is carried downwards in the side of the cervix so as to leave a thin

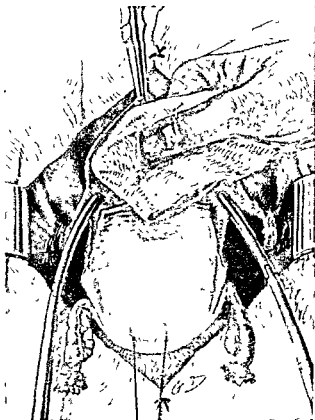


Fig. 1348.—TOTAL ABDOMINAL HISTERECTOMY. THE UTERINE VESSELS ARE CLAMPED AT THE LEVEL OF THE INTERNAL OS, AND THE BLADDER IS STRIPPED OFF THE ANTERIOR ASPECTS OF THE CERVIX AND VAGINA WITH GAUZE PRESSURE.

strip of muscle about $\frac{1}{4}$ inch thick and $\frac{1}{2}$ inch wide, until the lateral vaginal fornix is entered (fig. 1349). The same procedure is repeated on the other side.

The uterus is now pulled backwards and the anterior vaginal wall is cut across distal to its junction with the cervix, the incision joining the lateral openings on each side (fig. 1350).

At this stage the vaginal packing is removed.

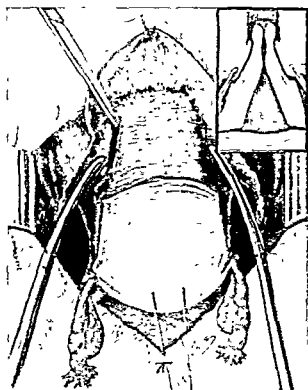


Fig 1349.—TOTAL ABDOMINAL HYSTERECTOMY. AN INCISION IS CARRIED DOWN THE SIDE OF THE CERVIX CUTTING THE CERVICAL MUSCLE SO THAT A THIN STRIP OF THIS MUSCLE IS LEFT ON EACH SIDE. INSET IS A SECTION SHOWING HOW EACH LATERAL INCISION IN THE CERVICAL SUBSTANCE IS CARRIED THROUGH THE VAGINAL VAULT SO THAT THE ENTIRE VAGINAL PORTION OF THE CERVIX IS REMOVED.

Finally, the uterus is pulled forwards and the vagina is divided posteriorly near its attachment to the cervix. This incision extended laterally divides the utero-sacral ligaments which are picked up preparatory to ligature (fig. 1351). The uterus should be inspected to ensure that all the vaginal portion of the cervix has been removed; if any fragment remains it must be excised.

Bleeding will occur from the cut edges of the vagina, especially the posterior margin, and from the strips of cervical muscle on each side.

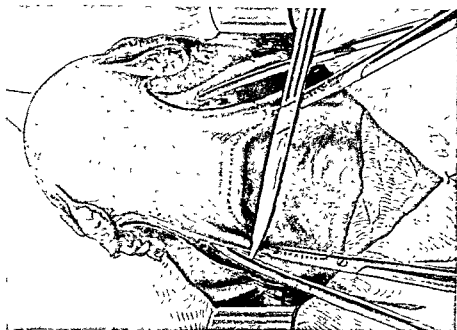


Fig. 1351.—TOTAL ABDOMINAL HYSTERECTOMY. THE UTERUS IS PULLED FIRMLY UPWARDS AND TOWARDS THE PUBES. THE UTERO-VESICAL LIGAMENTS HAVING BEEN CLAMPED ARE THEN DIVIDED. THE LINE OF DIVISION OF THESE LIGAMENTS AND OF THE POSTERIOR VAGINAL WALL IS INDICATED BY A DOTTED LINE.

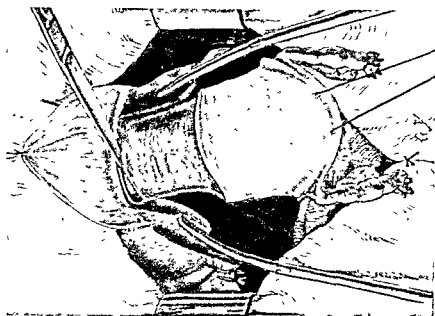


Fig. 1350.—TOTAL ABDOMINAL HYSTERECTOMY. THE ANTERIOR VAGINAL WALL IS CUT ACROSS TRANSVERSELY. THE PACKING INSIDE THE VAGINA CAN JUST BE SEEN AS THE LATTER IS OPENED.

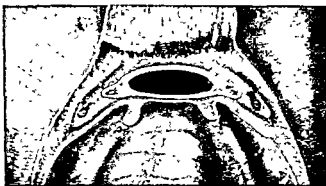


Fig. 1352.—TOTAL ABDOMINAL HYSTERECTOMY. THE UTERUS HAS BEEN REMOVED. IN THE CENTRE IS THE OPENED UPPER END OF THE VAGINA, ON EACH SIDE OF WHICH IS A SMALL STRIP OF CERVICAL TISSUE WITH THE UTERINE VESSELS TIED AT THE UPPER END. BEHIND ON EACH SIDE OF THE RECTUM ARE THE UTERO-SACRAL LIGAMENTS WITH A STITCH AROUND EACH SO THAT THEY CAN BE IDENTIFIED LATER DURING THE PROCESS OF SEWING UP. WHEN THEY ARE COLLAPSED THEY ARE DIFFICULT TO FIND. IN FRONT OF THE VAGINA IS THE BLADDER.

The uterine arteries are doubly tied on each side with catgut which is carried on a needle through the strip of cervical muscle (fig. 1352).

The cut end of the vagina is closed by a continuous catgut stitch which pierces the whole thickness of the anterior and posterior walls. The lateral angles of the vagina and the two strips of cervical muscle are then approximated with interrupted stitches or by utilising the suture used for closing the vagina (fig. 1353). The cut ends of the utero-sacral ligaments are next sewn together and secured to the approximated strips of cervical muscle and sutured vagina (fig. 1354). By this

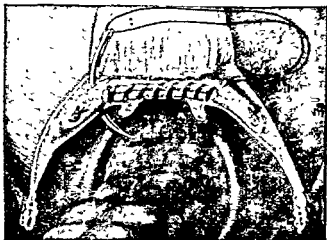


Fig. 1353.—TOTAL ABDOMINAL HYSTERECTOMY. THE UPPER END OF THE VAGINA HAS BEEN SUTURED AND THE STITCH IS PASSED THROUGH THE SMALL STRIP OF CERVICAL MUSCLE ON EACH SIDE ALTERNATELY SO AS TO BRING THESE STRIPS TOGETHER IN THE MIDDLE LINE.

means the transverse cervical (cervico-pelvic) ligaments which are attached to the strips of cervical muscle on each side are drawn taut and fixed together in the mid-line; these, and to a less extent the utero-sacral ligaments, form a strong support for the vaginal vault.

The anterior and posterior edges of the peritoneum in the bottom of the pouch of Douglas are approximated by a continuous catgut

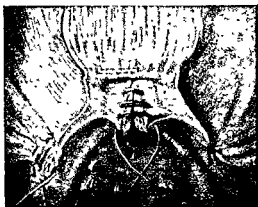


Fig. 1354.—TOTAL ABDOMINAL HYSTERECTOMY. THE TWO SMALL LATERAL STRIPS OF THE CERVIX ARE SEWN TOGETHER IN THE MIDLINE AND THE ANTERIOR ENDS OF THE UTERO-SACRAL LIGAMENTS ARE FIRMLY SEWN TOGETHER AND TO THE BACK OF THE TWO STRIPS OF CERVICAL MUSCLE. ON THE LEFT A PURSE STRING SUTURE IS INSERTED IN THE PERITONEUM AROUND THE STUMP OF THE OVARIO-PELVIC AND ROUND LIGAMENTS. AS THIS IS TIED THE STUMPS ARE NEATLY BURIED AS SHOWN ON THE RIGHT SIDE OF THE PICTURE.



Fig. 1355.—TOTAL ABDOMINAL HYSTERECTOMY. THE OPERATION COMPLETED.

stitch. The ligated stumps of the ovario-pelvic and round ligaments are invaginated by a purse-string suture if possible. When suturing the central portion of the anterior flap of peritoneum, the bladder should be lifted up on to the strips of cervical muscle and the free edge of peritoneum infolded and sewn to the approximated ends of the utero-sacral ligaments (fig. 1355).

The chief difficulty is that of working in a deep cavity, and this is increased when the abdominal parietes are not divided to their lowest level, are not fully retracted, or are rigid. Free exposure is also impeded when bowel obtrudes into the field of operation, or when the bladder is not completely emptied. Deposition of fat in the recto-sigmoid portion of the gut and in the extra-peritoneal tissues also renders the operation less easy.

Dangers are those of cutting or ligating one or both ureters, wounding the bladder or rectum, or puncturing large vessels. Post-operative vaginal bleeding will occur unless the entire thickness of the vaginal wall is sutured.

Special After-Treatment. A sterile dressing is applied to the vulva. The vagina is irrigated on the second day with a 10 per cent eusol solution by means of a rubber catheter and glass syringe. Should there be a foul discharge during convalescence, the vagina must again be irrigated and 2 dr. of glycerine instilled twice daily. Douching must be avoided lest the fluid under pressure should open up the sutured vault and invade the peritoneal cavity.

Technique recommended when there is a Malignant Growth in the Body of the Uterus :

A small strip of gauze soaked in the antiseptic solution is packed tightly into the cervix to prevent the escape of any malignant cells during subsequent manipulations. The vagina is then packed.

The fundus should not be grasped with the vulsellum or pierced with a tractor stitch, as there is danger of disseminating carcinoma cells. The broad ligaments on each side are clamped close to the uterus with artery forceps which are used as tractors.

The steps of the operation up to the clamping of the uterine vessels are the same as those described in the previous operation.

It should be emphasised that for this condition no strip of cervical muscle is left behind, and the tubes and ovaries are always removed.

The uterine vessels are clamped with artery forceps which are placed parallel with and close to the cervix, the points of the jaws being pressed against the vaginal vault. The para-cervical tissues are now divided, the incision on each side being carried directly downwards into the lateral vaginal fornix, and the anterior fornix is opened by cutting across the vaginal wall between the two lateral incisions. The posterior wall is similarly divided and all cervical tissues are completely excised.

The uterine vessels are doubly ligated, and a stitch is passed through the vaginal wall at its lateral angle so as not to include the mucous membrane. This is tied around the uterine vessels proximal to the clamp which is not removed. A second stitch is inserted distal to the first and tied in the groove made by the clamp as this is removed. The vaginal vault is closed as in the previous operation. The lateral angles of the vagina can usually be folded in so as to meet in the mid-line, in this way tightening the cervico-pelvic ligaments. Occasionally the stumps of connective tissue and uterine vessels may be approximated in the mid-line and tied together, provided no tension is thus produced. Further support for the vault is obtained by securing the ends of the utero-sacral ligaments to the sutured stump of the vagina.

Closure of the peritoneum is the same as described in the previous operation.

SUB-TOTAL HYSTERECTOMY

Indications (see page 2477).

Contra-indications. This operation should never be performed when there is malignant disease, tuberculosis or other chronic infection of

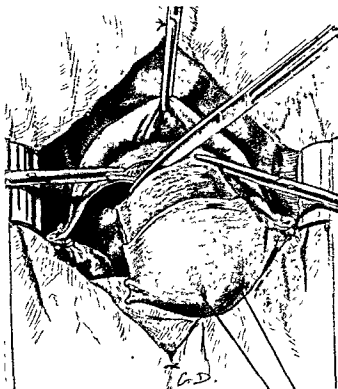


Fig. 1356.—SUB TOTAL HYSTERECTOMY. THE BROAD LIGAMENT ON EACH SIDE IS PIERCED AND TIED, SECURED TO THE ROUND LIGAMENT, AND THEN DIVIDED DOWN TO ITS BASE. THE PERITONEUM ACROSS THE FRONT OF THE UTERUS IS DIVIDED AT THE LEVEL OF LOOSE REFLECTION FROM THE BLADDER AND PULLED DOWNWARDS. THE UTERINE VESSELS ARE SECURED WITH CLAMPS ON EACH SIDE AND THE CERVIX IS CUT ACROSS IMMEDIATELY ABOVE ITS ATTACHMENT TO THE VAGINA.

the uterus, when there is laceration, injury or infection of the cervix, profuse discharge, recurring attacks of trigonitis and cystitis, or first degree utero-vaginal prolapse.

Advantages. This operation can be performed more quickly and more easily than the total operation, especially in very fat patients; there is also slightly less risk of injury to the ureters, bladder or rectum, or of the spread of sepsis from the vagina.

Special After-Treatment. A sterile dressing is applied to the vulva. The vagina is irrigated on the second day with a 10 per cent eusol solution by means of a rubber catheter and glass syringe. Should there be a foul discharge during convalescence, the vagina must again be irrigated and 2 dr. of glycerine instilled twice daily. Douching must be avoided lest the fluid under pressure should open up the sutured vault and invade the peritoneal cavity.

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A small strip of gauze soaked in the antiseptic solution is packed tightly into the cervix to prevent the escape of any malignant cells during subsequent manipulations. The vagina is then packed.

The fundus should not be grasped with the vulsellum or pierced with a tractor stitch, as there is danger of disseminating carcinoma cells. The broad ligaments on each side are clamped close to the uterus with artery forceps which are used as tractors.

The steps of the operation up to the clamping of the uterine vessels are the same as those described in the previous operation.

It should be emphasised that for this condition no strip of cervical muscle is left behind, and the tubes and ovaries are always removed.

The uterine vessels are clamped with artery forceps which are placed parallel with and close to the cervix, the points of the jaws being pressed against the vaginal vault. The para-cervical tissues are now divided, the incision on each side being carried directly downwards into the lateral vaginal fornix, and the anterior fornix is opened by cutting across the vaginal wall between the two lateral incisions. The posterior wall is similarly divided and all cervical tissues are completely excised.

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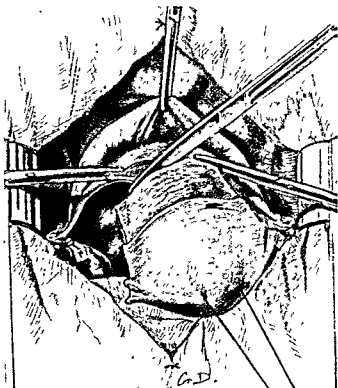


Fig. 1356.—SUB-TOTAL HYSTERECTOMY. THE BROAD LIGAMENT ON EACH SIDE IS PIERCED AND TIED, SECURED TO THE ROUND LIGAMENT, AND THEN DIVIDED DOWN TO ITS BASE. THE PERITONEUM ACROSS THE FRONT OF THE UTERUS IS DIVIDED AT THE LEVEL OF LOOSE REFLECTION FROM THE BLADDER AND PULLED DOWNWARDS. THE UTERINE VESSELS ARE SECURED WITH CLAMPS ON EACH SIDE AND THE CERVIX IS CUT ACROSS IMMEDIATELY ABOVE ITS ATTACHMENT TO THE VAGINA.

the uterus, when there is laceration, injury or infection of the cervix, profuse discharge, recurring attacks of trigonitis and cystitis, or first degree utero-vaginal prolapse.

Advantages. This operation can be performed more quickly and more easily than the total operation, especially in very fat patients; there is also slightly less risk of injury to the ureters, bladder or rectum, or of the spread of sepsis from the vagina.

Disadvantages. If the cervix is left *in situ* it may subsequently become infected with or harbour gonococci, be the source of vaginal discharge, a focus of infection causing trigonitis and cystitis, and possibly other inflammations such as arthritis, or be the seat of carcinoma.

The operation is conducted in a manner similar to total hysterectomy until the uterine arteries have been clamped on each side at the level of the internal os (fig. 1356). At this stage the cervix is cut across

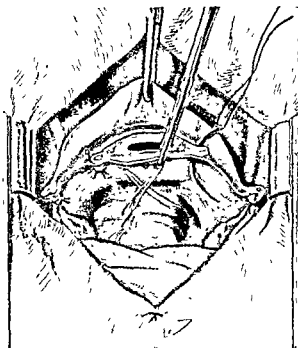


Fig. 1357.—SUB TOTAL HYSTERECTOMY. THE CERVICAL CANAL IS CLOSED AND THE EDGES OF THE CERVICAL STUMP ARE APPROXIMATED WITH A BLANKET STITCH. THE RIGHT UTERINE VESSELS ARE BEING UNDERRUN PRIOR TO LIGATION.

so as to leave a slightly transverse V-shaped hollow portion. The uterine vessels are then ligated by passing a stitch through the substance of the cervix on each side below the clamps and around the uterine vessels. A blanket stitch is passed through the anterior and posterior cut edges of the cervix so as to approximate these over the upper opening of the cervical canal (fig. 1357).

The peritoneum reflected from the bladder is now sutured to the cut broad and round ligaments on each side and to the back of the central part of the cervical stump. The stumps of the broad and round ligaments on each side are buried if possible by a purse-string suture (figs. 1358 and 1359).

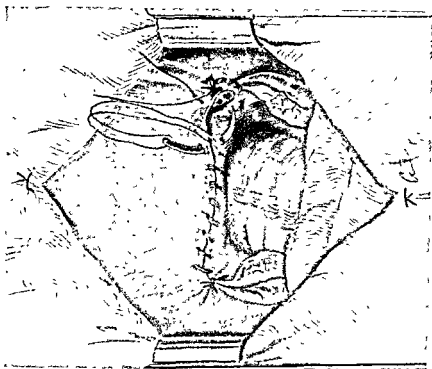


Fig. 1333.—SUB TOTAL HYSTERECTOMY. COMPLETION OF REPOSITIONING. ON THE RIGHT THE STUMPS OF THE BROAD AND ROUND LIGAMENTS ARE BEING INFOLDED BY A PURSE STRING SUTURE, BOTH TUBES AND OVARIES REMAIN IN SITU.

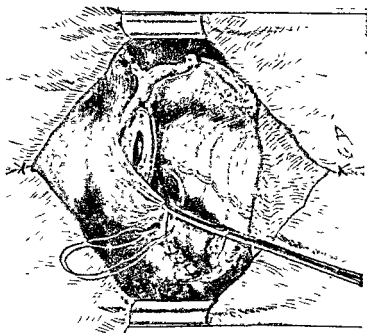


Fig. 1334.—SUB TOTAL HYSTERECTOMY. THE CUT EDGES OF THE PERITONEUM ARE JOINED BY A CONTINUOUS SUTURE, THE ANTERIOR FLAP BEING PULLED WELL OVER THE STUMP OF THE CERVIX AND SEWN ALONG ITS POSTERIOR ASPECT.

EFFECTS OF HYSTERECTOMY ON SEXUAL FUNCTION

McEwan (*B.M.J.*, p. 574, March 31, 1934) reported on 112 cases of hysterectomy, 10 of which were total and 98 sub-total. In 80 of these cases the results on sexual function were as follows :

Normal	55
Indifferent	5
Discontinued	20

64 Cases—Sex feelings :

Increased	3
Unchanged	34
Diminished	11
Disappeared	16

Of the 112, both appendages were removed in 91 cases (81 per cent). In this series the results must have been considerably affected by the superadded removal of the ovaries, and yet in spite of this sex relations were normal in 65 per cent and sex feelings undiminished in 54 per cent. Of these 112 patients it must also be noted that 86 were between 35 and 40 years of age, and 58 were over 40. Subtracting the effects of advancing age and removal of the ovaries, the influence of hysterectomy on sexual relations and feelings would appear to be very slight.

My own enquiries from patients have led me to believe that hysterectomy, even the total operation, has little effect on sex relations or feelings where these were normal before operation.

WHEN IS HYSTERECTOMY INDICATED IN CASES OF BILATERAL SALPINGO-OÖPHORITIS ?

Hysterectomy should not be advised if uterine hæmorrhage has been only slight or if even a portion of one ovary can be conserved, as the presence of part of an ovary may cause menstruation to continue and some of the unpleasant symptoms of the menopause may thereby be avoided. When, however, bilateral salpingo-oöphorectomy has been performed for chronic tubo-ovarian abscesses or tubo-ovarian cysts, total hysterectomy is indicated.

When both tubes and ovaries are removed on account of acute suppuration, especially if the uterus is large and soft, and there has been severe uterine hæmorrhage, sub-total hysterectomy is the operation of choice, as it can be more easily and quickly performed than the total operation, and there is less opening up of raw areas. It is true that in such cases the cervix, which is almost always

chronically infected, is left *in situ*, but this structure can easily be removed by the vaginal route on a subsequent occasion, should this prove necessary.

HYSTERECTOMY FOR FIBROMYOMA OF THE CERVIX

A fibromyoma growing in the cervix, from the lateral aspect of the lower part of the uterus, or from the fibro-muscular tissues in the base of the broad ligament, cannot be removed by total or sub-total hysterectomy by the methods just described, because the tumour, if large, fills and remains impacted in the pelvic cavity, the surrounding structures are displaced, and the vaginal vault and uterine vessels are inaccessible. The steps of the operation must be modified in accordance with the position of the tumour which may be :

- (a) *Central.* The myoma is either interstitial or submucous, expanding the cervix in all directions, the pelvic cavity being to a greater or lesser extent filled and the uterus standing high on the top of the tumour.
- (b) *Anterior.* The myoma arises in the anterior wall of the cervix, expanding under and elevating the bladder.
- (c) *Posterior.* The myoma grows from a corresponding site in the back of the cervix and bulges backwards, filling the pouch of Douglas and compressing the rectum antero-posteriorly. On rare occasions it expands under the peritoneum, elevating and stripping it from the sacrum and rectum.
- (d) *Lateral.* The myoma grows from one or other lateral aspect of the cervix between the layers of the broad ligament and often under the sigmoid colon which lies stretched over its convexity. These lateral tumours usually grow out over the top of the ureter, but on rare occasions when they originate very low down in the cervix they may lift the ureter which will then run across its upper surface.

(a) *Hysterectomy for Central Fibromyoma of the Cervix.* A general examination is first made to determine as far as possible the anatomical relationships. The round ligaments are sought for, and by following them to their attachments the body of the uterus is located.

The upper border of each broad ligament is identified and the

vessels in this situation are underrun, tied in two places, and divided between the ligatures. The round ligaments are similarly cut, and the peritoneum is incised between these points to the level of its loose reflection (fig. 1360). The bladder can then be stripped downwards from the front of the expanded cervix (fig. 1361).

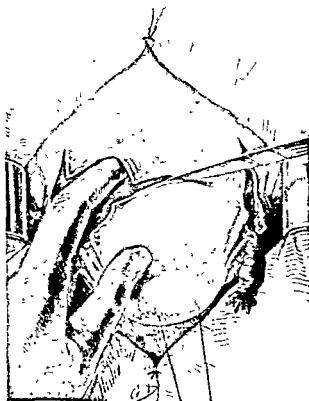


Fig. 1360.—HYSTERECTOMY FOR CENTRAL FIBROID OF THE CERVIX. THE OVARIO-PELVIC AND ROUND LIGAMENTS ARE SEPARATELY LIGATED, AND THEN TIED TOGETHER. THESE AND THE BROAD LIGAMENTS HAVE BEEN DIVIDED, AND THE UTERUS DRAWN UPWARDS. THE PERITONEUM AT ITS LOOSE REFLECTION FROM THE FRONT OF THE UTERUS IS BEING DIVIDED AND STRIPPED OFF WITH THE FINGER.

A transverse incision from 2 to 3 inches long is made through the capsule into the substance of the tumour on its anterior aspect (fig. 1362). A myomectomy screw is then inserted into the fibroid which is lifted and rotated in all directions, while at the same time the fingers and scissors strip it from its bed (figs. 1363 and 1364).

The expanded cervix now collapses, the uterine vessels are identified and clamped, and the operation is completed in a similar manner to a total or sub-total hysterectomy (fig. 1365).

Differentiation between the attenuated supra-vaginal cervix and the vagina is simplified if the latter is packed prior to the operation.

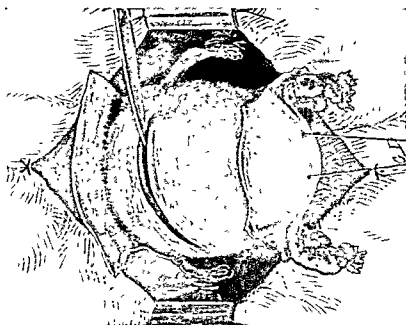


Fig. 1342.—HYSTERECTOMY FOR CENTRAL FIBROID OF THE CERVIX. THE CAPSULE OF THE MYOMA IS INCISED ACROSS ITS ANTERIOR ASPECT.

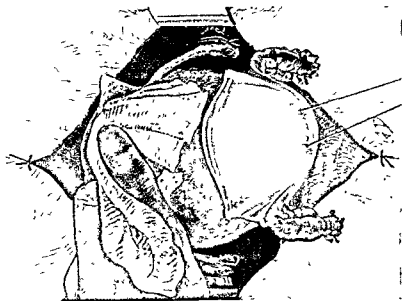


Fig. 1341.—HYSTERECTOMY FOR CENTRAL FIBROID OF THE CERVIX. THE BLADDER IS BEING STRIPPED OFF THE EXPANDED PORTION OF THE CERVIX BY GAUZE PRESSURE.

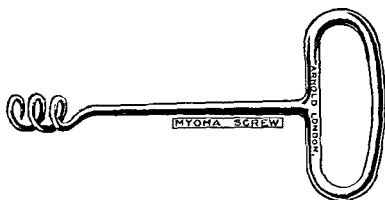


Fig. 1363.--MYOMECTOMY SCREW.

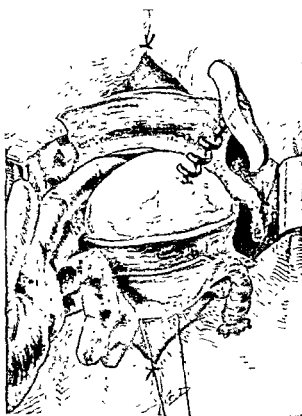


Fig. 1364.—HISTERECTOMY FOR CENTRAL FIBROID OF THE CERVIX. A MYOMECTOMY SCREW IS INSERTED INTO THE TUMOUR WHICH IS ROTATED AND PULLED UPWARDS; AT THE SAME TIME THE FINGERS STRIP IT FROM ITS BED.

An Alternative Method of Hysterectomy by Splitting the Uterus. This method is suitable for those cases where the bladder is so elevated that it cannot be easily separated.

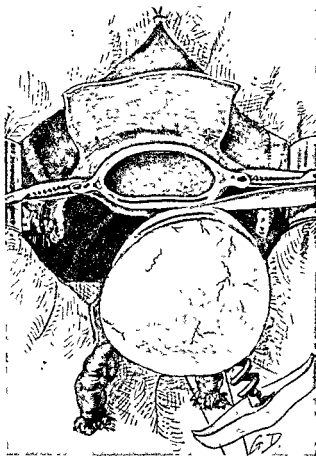


Fig. 1365.—HYSTERECTOMY FOR CENTRAL FIBROID OF THE CERVIX. THE TUMOUR HAVING BEEN FREED FROM ITS BED AND ROTATED UPWARDS, THE UTERINE VESSELS COME INTO VIEW ON EACH SIDE AND ARE CLAMPED. THE REMAINING PORTION OF THE CERVIX IS THEN CUT ACROSS AND THE TUMOUR AND UTERUS ARE REMOVED. THE ILLUSTRATION SHOWS THE GREATLY ENLARGED CERVIX WITH A SMALL PART OF THE BED OF THE TUMOUR IN THE ANTERIOR WALL. BEHIND THE MYOMA CAVITY CAN BE SEEN THE VERY WIDE BUT FLATTENED CERVICAL CANAL. THE REMAINING PORTION OF THE CERVIX MAY NOW BE EXCISED AS IN TOTAL HYSTERECTOMY OR IT MAY BE SUTURED AND LEFT AS IN SUB-TOTAL HYSTERECTOMY.

Procedure. The round ligaments are identified, tied and divided at the highest level of loose attachment of the peritoneum which is transversely incised, and the bladder is stripped from the expanded cervix and pushed downwards as far as possible (fig. 1366).

The ovarian vessels and broad ligaments are tied and divided as in the previous operation. The uterus is then split antero-posteriorly, each half is retracted laterally, and the capsule of the tumour is deeply

incised (fig. 1367). The myomectomy screw is inserted, the tumour is enucleated, and the operation is completed as in total or sub-total hysterectomy (fig. 1368).

(b) *Hysterectomy for Anterior Fibromyoma of the Cervix.* A fibroid growing in the anterior wall of the cervix may either elevate the bladder on its upper surface or grow up between the bladder and its covering

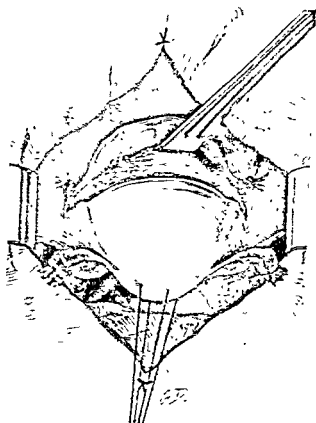


FIG. 1366.—HYSTERECTOMY FOR CENTRAL FIBROID BY SPLITTING THE UTERUS. THE ROUND LIGAMENTS ARE UNDERLY, TIED AND DIVIDED, THE PERITONEUM IS CUT TRANSVERSELY ALONG THE LINE OF LOOSE REFLECTION, AND THE BLADDER IS PUSHED DOWNWARDS BY BLUNT DISSECTION AND SWAB PRESSURE.

peritoneum. In the first type of case the bladder is so elevated that it may be injured when the abdomen is opened; in the second, the peritoneum is so extensively stripped off the bladder that there is not sufficient to cover the raw surface after the operation unless the peritoneum is incised as near as possible to the line of its attachment to the front of the uterus. The round ligaments are liable to be mistaken for the upper parts of the broad ligaments which contain the ovarian vessels, as they are frequently so much lifted up by the myoma that

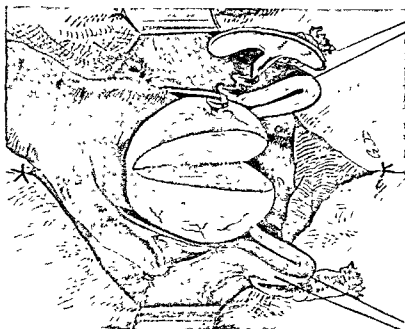


Fig 136.—HYSTERECTOMY FOR CENTRAL FIBROID BY SPLITTING THE UTERUS. THE MYOMECTOMY SCREW HAVING BEEN INSERTED, THE TUMOUR IS ROTATED AND PULLED UPWARDS AND IS STRIPPED WITH THE FINGERS FROM ITS CAPSULE.

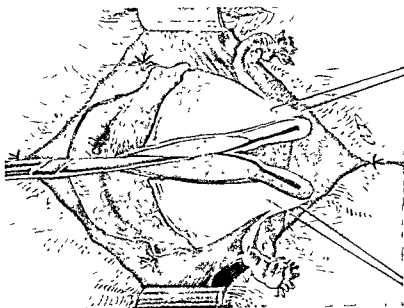


Fig 137.—HYSTERECTOMY FOR CENTRAL FIBROID BY SPLITTING THE UTERUS. THE BLADDER HAVING BEEN PUSHED WELL DOWNWARDS AND FORWARDS, THE UTERUS IS DISSECTED AND THE ANTERIOR ASPECT OF THE CAPSULE OF THE FIBROID IS DIVIDED.

they form the highest ridge, while the uterus is retroverted and the tubes and ovaries are out of sight posteriorly.

The round ligaments are tied and cut, and the peritoneum on the upper surface of the expanded cervix is incised transversely as near as possible to its reflection from the front of the uterus so as to provide a long flap. The point of attachment can be determined by tunnelling under the peritoneum with the finger or a pair of forceps.

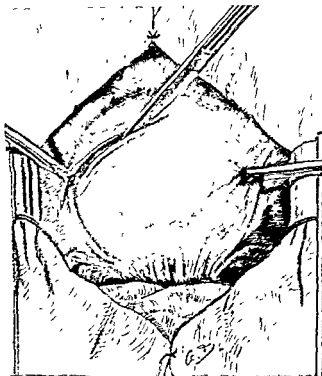


Fig. 1309.—HYSTERECTOMY FOR RETROPERITONEAL POSTERIOR CERVICAL FIBROID. THE PERITONEUM OF THE POUCH OF DOUGLAS HAS BEEN ELEVATED SO THAT THE FUNDUS OF THE UTERUS IS VIRTUALLY UNDER THE PERITONEUM. THE OPERATION HERE DEPICTED IS BONNEY'S METHOD MODIFIED. THE ROUND LIGAMENTS ON EACH SIDE ARE CLAMPED AND THE PERITONEUM IS INCISED TRANSVERSELY ALONG THE LINE OF ITS LOOSE ATTACHMENT.

The tumour is then enucleated as in the previous operation, after which the ovarian vessels are secured and total or sub-total hysterectomy performed.

(c) *Hysterectomy for Posterior Fibromyoma of the Cervix.* There are two situations in which a posterior cervical fibromyoma may grow: (1) Transperitoneally; or (2) Retroperitoneally. A different operative technique is required for each.

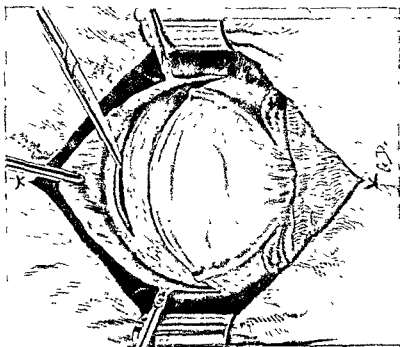


Fig. 1371.—HYSTERECTOMY FOR RETROPERITONEAL POSTERIOR CERVICAL FIBROID. THE BLADDER IS FILLED DOWNWARDS AND THE ANTERIOR VAGINAL WALL IS OPENED.

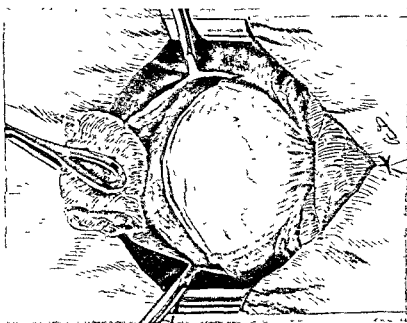


Fig. 1370.—HYSTERECTOMY FOR RETROPERITONEAL POSTERIOR CERVICAL FIBROID. THE BLADDER IS STRIPPED OFF THE FRONT OF THE CERVIX AND THE ANTERIOR ASPECT OF THE VAGINA.

Hysterectomy for a Fibroid Bulging Backwards into the Pouch of Douglas. The procedure here is the same as that for removal of a central cervical fibromyoma. After the ovarian vessels and round ligaments have been ligated and divided together with the broad ligaments, the uterus is pulled upwards and towards the pubes, and the capsule of the tumour is incised behind the uterus at the junction of the expanded cervix and posterior uterine surface. The tumour is now enucleated from its bed and the uterus removed.

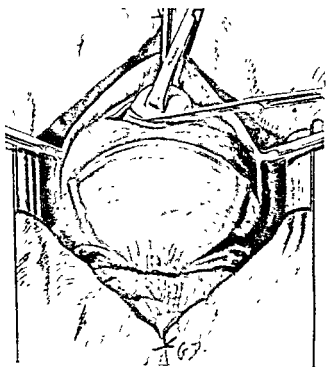


Fig. 1372.—HYSTERECTOMY FOR RETROPERITONEAL POSTERIOR CERVICAL FIBROID. THE CERVIX IS GRASPED WITH A VULSELLUM AND PULLED THROUGH THE NEW-MADE OPENING IN THE ANTERIOR VAGINAL WALL. AS THE CERVIX IS DRAWN UPWARDS AND FORWARDS THE VAGINAL WALL IS INCISED ALL AROUND.

Hysterectomy for Retroperitoneal Posterior Cervical Fibroid. This is a rare condition in which the fibromyoma lifts up the peritoneum from the bottom of the pouch of Douglas and off the front of the rectum and sacrum. The cervix and front of the vagina are elevated, and the fundus uteri is directed backwards and may appear to be adherent to the sigmoid colon. Anatomical relationships are greatly obscured.

A modification of *Bonney's operation* is the most satisfactory procedure whereby a myoma so placed can be safely removed.

The anterior aspects of the cervix and vagina are the highest and

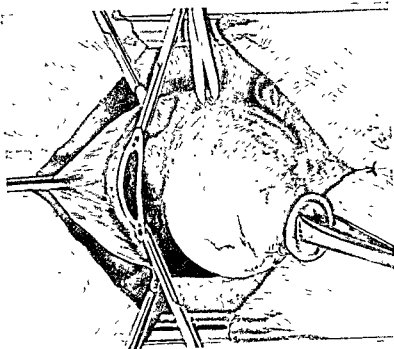


Fig. 1374.—HYSTERECTOMY FOR RETROPERITONEAL POSTERIOR CERVICAL FIBROID. THE VAGINAL WALL IS CUT AWAY ALL AROUND THE CERVIX, AND THE UTERINE VESSELS ARE TIED AT THE SIDE OF THE UTERUS. THE CERVIX IS PULLED BACK, AND THE FUNDUS AND FIBROID ARE FREED FOR A SHORT DISTANCE.

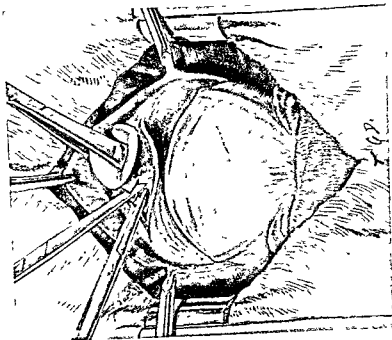


Fig. 1373.—HYSTERECTOMY FOR RETROPERITONEAL POSTERIOR CERVICAL FIBROID. FIRM TRACTION IS MADE UPWARDS ON THE CERVIX, AND THE UTERINE VESSELS ARE CLAMPED AS THEY COME INTO VIEW.

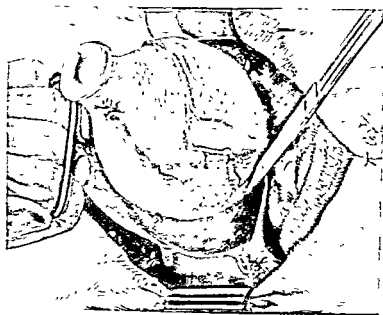


Fig. 1756.—HARTSHORN FOR RETROPERITONEAL POSTERIOR CERVICAL LIPOID. THE TUMOR IS LIFTED UP AND ROTATED FORWARD TOWARD THE SPINE AND THE FUNDUS OF THE UTERUS DIVIDED FROM MID TO SIDE ALONG THE LUNDS OF THE UTERUS.

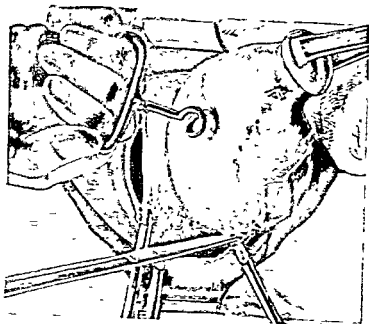


Fig. 1757.—HARTSHORN FOR RETROPERITONEAL POSTERIOR CERVICAL LIPOID. A LARGE MYOMECTOMY SCAR IS INSERTED INTO THE TUMOR WHICH IS ROTATED BACKWARD AND FROM MID TO SIDE, AND AT THE SAME TIME DIVIDED FROM MID TO SIDE. THE OVARIAN VESSELS ARE CLAMPED WHERE THEY REACH THE FUNDUS.

most accessible parts, and it is over these structures that the peritoneum is first incised. After the round ligaments have been divided the bladder is separated and retracted towards the pubes (figs. 1369 and 1370). The anterior vaginal fornix is then opened, the cervix is pulled through this opening (fig. 1371), the vagina is cut away all around, and the uterine vessels are clamped and tied (figs. 1372 and 1373).

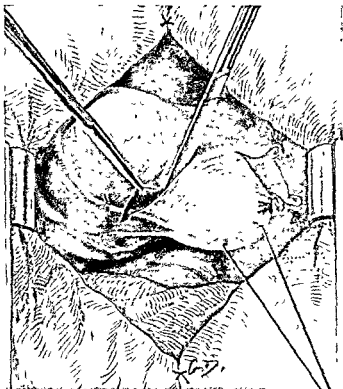


Fig. 1377.—HYSTERECTOMY FOR LATERAL FIBROID. THE RIGHT BROAD LIGAMENT IS SECURED BY TWO STITCHES BETWEEN WHICH IT IS DIVIDED DOWN TO ITS BASE. THE ROUND LIGAMENTS ON BOTH SIDES ARE DIVIDED AND THE PERITONEUM IS CUT ACROSS AT THE LEVEL OF ITS LOOSE REFLECTION FROM THE UTERUS ON TO THE BLADDER.

When the cervix has been freed, the uterus is drawn upwards and the fibroid is separated from the rectum by gauze pressure aided by sharp dissection, the myomectomy screw being used when the tumour is large and adherent (figs. 1374 and 1375). When the myoma has been lifted out of the pelvis the ovarian vessels are secured and cut and the uterus is removed by freeing it posteriorly from the peritoneum, of which the longest possible flap must be left (fig. 1376).

The operation is now completed as in total hysterectomy.

(d) *Hysterectomy for Lateral Fibromyoma.* True lateral cervical myomata are very rare; more frequently a tumour growing beside

the uterus and expanding the broad ligament has its origin in the lateral wall of the uterine body. Both are firmly attached to the uterus and elevate the uterine vessels which come to lie very close to the ovarian artery. There is a difference, however, in the relations of the ureter which lies below and lateral to a corporeal tumour and above a cervical growth.

Procedure. The ovarian vessels and round ligament on the side away from the tumour are divided. The opposite round ligament is

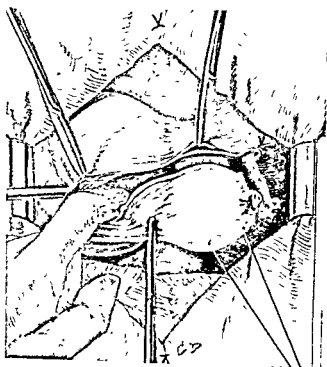


Fig. 1378.—HYSTERECTOMY FOR LATERAL FIBROID. THE ANTERIOR FLAP OF PERITONEUM IS REFLECTED DOWNWARDS AND THE MYOMA IS STRIPPED WITH THE FINGER FROM ITS BED IN THE BROAD LIGAMENT.

severed and the peritoneum incised across the front of the growth and at the point of its loose attachment to the uterus (fig. 1377). A finger is now inserted through the opening in the peritoneum, and the ovarian vessels and Fallopian tube on the affected side are separated from the myoma and cut between two ligatures (figs. 1378 and 1379).

The bladder is stripped from the front of the uterus and from the vagina.

The uterine vessels away from the growth are clamped and cut, and the cervix on this side is freed as in total hysterectomy. The

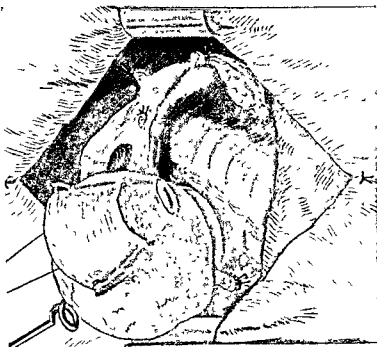


Fig. 1380.—HYSTERECTOMY FOR LATERAL FIBROID. THE UTERUS HAVING BEEN CUT FREE FROM THE UPPER PART OF THE VAGINA, ALL AROUND IS PULLED UPWARDS TOGETHER WITH THE MYOMA. LIGATION OF THE OVARIAN VESSELS ON THE RIGHT SIDE CAN BE SEEN.

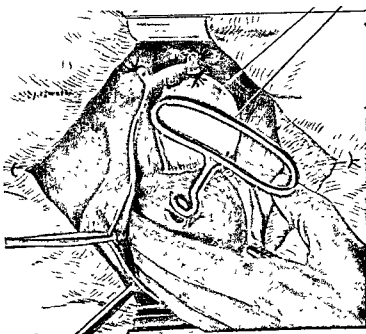


Fig. 1379.—HYSTERECTOMY FOR LATERAL FIBROID. THE MYOMA IS PULLED UPWARDS AND ROTATED WITH A MYOLECTOMY SCREW, WHICH IS FURTHER FREED FROM ITS BED WITH THE FINGERS.

cervix is cut away from the vagina, lifted up, and an incision is carried upwards in its musculature on the side of the myoma for about $1\frac{1}{2}$ inches. The uterine vessels on this side are then clamped and divided. The uterus is now free, and the tumour can be further stripped from its bed (fig. 1380).

The ureter on the affected side must be identified, and its exact position known at each stage of the procedure.

The operation is now completed as in total hysterectomy, the space in the broad ligament being obliterated with catgut stitches from the bottom upwards.

An Alternative Procedure.

When the fibroid is very large, pushing the uterus far to the opposite side and possibly downwards, the vessels here are inaccessible.

The operation will proceed as that just described until the anterior flap of the peritoneum and the bladder have been separated. The myomectomy screw is then inserted, and the tumour rotated, pulled upwards and stripped from its bed with the fingers; it can then be drawn well out of the way. The uterus is thus lifted upwards and its vessels become accessible. The remaining stage of the operation is similar to that for lateral fibromyoma.

The chief *danger* is injury to the ureter on the affected side. This is avoided by carrying the dissection very close to the tumour during enucleation, and by being acquainted with the exact position of the ureter.

HYSTEROTOMY

Hysterotomy is the operation of opening the uterine cavity by an incision through its wall. It may be performed via the vaginal or the abdominal route.

ABDOMINAL HYSTEROTOMY

Indications. This operation is employed in order to explore the uterine cavity during myomectomy, or for the performance of Cesarean section.

The operation has sometimes been performed for the removal of hydatidiform mole or of products of gestation in stages more advanced than the fifth month.

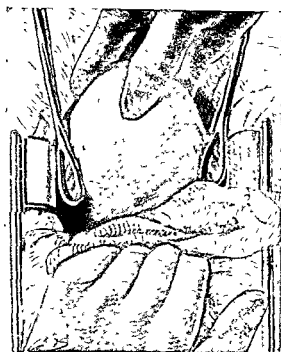


Fig. 1381.—ABDOMINAL HYSTEROTOMY. THE UTERUS IS LIFTED UP AND RING FORCEPS ARE APPLIED TO THE OVARIO-PELVIC LIGAMENTS.

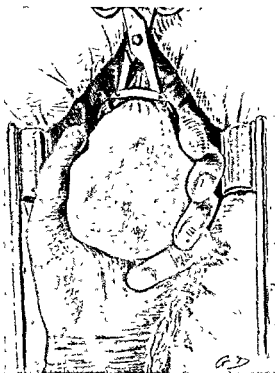


Fig. 1382.—ABDOMINAL HYSTEROTOMY. BONNEY'S MYOMECTOMY CLAMP IS APPLIED TO THE SUPRA-VAGINAL PORTION OF THE CERVIX INCLUDING THE ROUND LIGAMENTS.

Certain cases of severe uterine bleeding in young women may be treated by this operation when uterine curettage via the vagina has failed. This is, however, rarely necessary, but it must be admitted that apart from the disadvantage of opening the abdomen, the uterus can be evacuated and explored much more thoroughly and completely by abdominal hysterotomy than by any other method; also there is less risk of sepsis than with the vaginal operation.

Procedure. The abdomen is opened and the field of operation is prepared in the usual manner. The uterus is lifted up and carefully

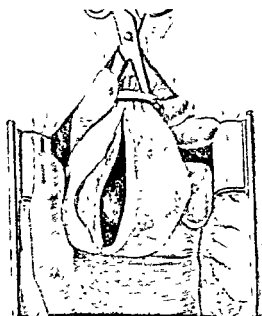


FIG. 1383.—ABDOMINAL HYSTEROTOMY. THE ANTERIOR UTERINE WALL IS INCISED.

examined for the presence of any myomata, and an intestinal clamp or a pair of ring forceps is applied to each ovario-pelvic ligament (fig. 1381), the upper part of the cervix uteri, including the two round ligaments, being grasped with the Bonney myomectomy clamp which controls bleeding from below and steadies the uterine body (fig. 1382).

An incision is made through the uterus in the anterior wall in the mid-line from the top of the fundus down to the level of the loose reflection of peritoneum below, and the edges of the opening are retracted (fig. 1383). The cavity is explored with the finger, and if necessary its contents are evacuated, care being taken to examine the cornua for carcinoma, polypi or seedling fibroids.

Any submucous myoma, if present, is enucleated and its cavity

obliterated with a blanket stitch. Polypi can be removed with a sharp scoop, and the mucosa scraped away down to the muscularis.

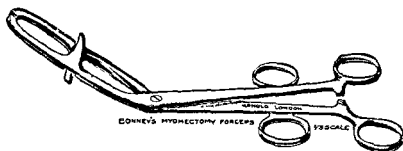


Fig. 1384.—DONNEY'S MYOMECTOMY CLAMP. THE BLADES ARE COVERED WITH RUBBER TUBING. THIS CLAMP IS USED TO GRASP THE SUPRA-VAGINAL CERVIX AND THE ROUND LIGAMENTS, THUS CONTROLLING THE CIRCULATION FROM THE UTERINE VESSELS AND VAGINO-UTERINE VASCULAR COMMUNICATIONS.

Suture of the uterus, completion of the operation, after-treatment, dangers and difficulties are the same as for myomectomy.

UTRICULOPLASTY

This is the operation whereby a large central wedge of the uterine body is removed in order to reduce its size and diminish the area of its menstruating surface.

Indications. The operation is applicable to cases of young women with severe intractable uterine hæmorrhage such as metropathia hæmorrhagica when other methods of treatment, e.g. curettage, have failed.

Contra-indication. The presence of uterine sepsis.

Advantages. The uterus is preserved and the functions of menstruation, and possibly of child-bearing, are maintained. The operation is an alternative to the more radical procedure of hysterectomy.

Disadvantages. Hysterectomy may subsequently be necessary on account of the recurrence of persistent and severe bleeding. The patient should be fully acquainted with the nature of the operation and the possibility of its failure.

Procedure. Clamps are applied as in hysterotomy. A wedge-shaped segment of the body of the uterus with its apex $\frac{1}{4}$ inch above the level of the internal os is outlined on both back and front of the uterus.

Certain cases of severe uterine bleeding in young women may be treated by this operation when uterine curettage via the vagina has failed. This is, however, rarely necessary, but it must be admitted that apart from the disadvantage of opening the abdomen, the uterus can be evacuated and explored much more thoroughly and completely by abdominal hysterotomy than by any other method; also there is less risk of sepsis than with the vaginal operation.

Procedure. The abdomen is opened and the field of operation is prepared in the usual manner. The uterus is lifted up and carefully

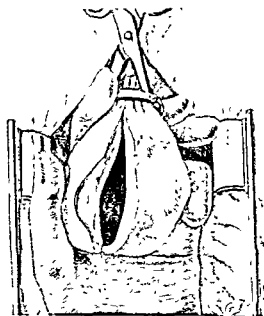


Fig. 1383.—ABDOMINAL HYSTEROTOMY. THE ANTERIOR UTERINE WALL IS INCISED.

examined for the presence of any myomata, and an intestinal clamp or a pair of ring forceps is applied to each ovario-pelvic ligament (fig. 1381), the upper part of the cervix uteri, including the two round ligaments, being grasped with the Bonney myomectomy clamp which controls bleeding from below and steadies the uterine body (fig. 1382).

An incision is made through the uterus in the anterior wall in the mid-line from the top of the fundus down to the level of the loose reflection of peritoneum below, and the edges of the opening are retracted (fig. 1383). The cavity is explored with the finger, and if necessary its contents are evacuated, care being taken to examine the cornua for carcinoma, polypi or seedling fibroids.

Any submucous myoma, if present, is enucleated and its cavity

obliterated with a blanket stitch. Polypi can be removed with a sharp scoop, and the mucosa scraped away down to the muscularis.

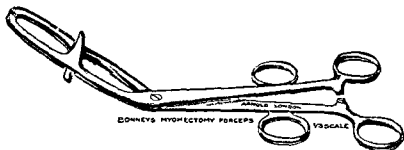


Fig. 1384.—BONNEY'S MYOMECTOMY CLAMP. THE BLADES ARE COVERED WITH RUBBER TUBING. THIS CLAMP IS USED TO GRASP THE SUPRA-VAGINAL CERVIX AND THE ROUND LIGAMENTS, THUS CONTROLLING THE CIRCULATION FROM THE UTERINE VESSELS AND VAGINO-UTERINE VASCULAR COMMUNICATIONS.

Suture of the uterus, completion of the operation, after-treatment, dangers and difficulties are the same as for myomectomy.

UTRICULOPLASTY

This is the operation whereby a large central wedge of the uterine body is removed in order to reduce its size and diminish the area of its menstruating surface.

Indications. The operation is applicable to cases of young women with severe intractable uterine hæmorrhage such as metropathia hæmorrhagica when other methods of treatment, e.g. curettage, have failed.

Contra-indication. The presence of uterine sepsis.

Advantages. The uterus is preserved and the functions of menstruation, and possibly of child-bearing, are maintained. The operation is an alternative to the more radical procedure of hysterectomy.

Disadvantages. Hysterectomy may subsequently be necessary on account of the recurrence of persistent and severe bleeding. The patient should be fully acquainted with the nature of the operation and the possibility of its failure.

Procedure. Clamps are applied as in hysterotomy. A wedge-shaped segment of the body of the uterus with its apex $\frac{1}{2}$ inch above the level of the internal os is outlined on both back and front of the uterus.

The base of the wedge is at the fundus and extends to within $\frac{1}{2}$ inch of the attachment of the Fallopian tube on each side.

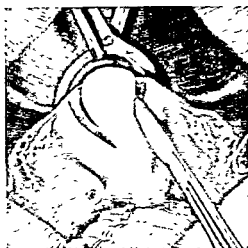


Fig. 1383.—CERVICOPLASTY. A WEDGE OF THE UTERINE BODY WITH ITS BASE AT THE FUNDUS AND ITS APEX AT THE INTERNAL OS IS EXCISED. HEMOSTASIS IS MEANWHILE SECURED BY PLACING A MYOHYSTERECTOMY CLAMP ON THE SUPRA VAGINAL CERVIX AND RING FORCEPS ON EACH OVARIO-PELVIC LIGAMENT.

The demarcated segment which includes the whole thickness of the anterior and posterior walls is excised (fig. 1385), leaving the lateral portions of the uterus on each side. The cut edges of the uterus are now approximated and the corresponding portions of the opposing walls are joined together by four or five deep mattress sutures of

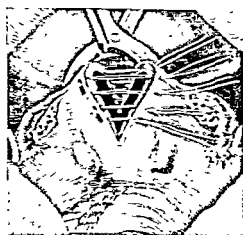


Fig. 1384.—CERVICOPLASTY. BLANEY CATGUT SUTURES APPROXIMATE THE EDGES OF EACH LATERAL PORTION OF THE UTERUS AND ARREST BLEEDING.

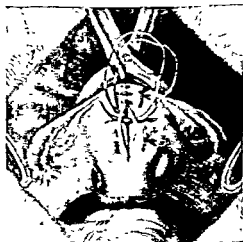


Fig. 1387.—CERVICOPLASTY. THE LATERAL HALVES OF THE UTERUS BEING APPROXIMATED WITH BLANEY SUTURES, THE CUT EDGES ARE OVERLAIN WITH A CONTINUOUS SUTURE.

catgut, which are passed so as to include the whole thickness of the wall except the mucosa (fig. 1386). The edges of the peritoneum are united by a continuous suture of fine catgut on an intestinal needle, neatly inverting the margin and leaving no raw area to which adhesions may form (fig. 1387). The hæmostatic clamps are all removed and the utriculus is carefully inspected for any further oozing, which must be controlled by mattress stitches.

ABDOMINAL MYOMECTOMY

This is the operation whereby one or more myomata are removed by enucleation, the uterus being conserved.

Advantages. As the uterus is conserved, pregnancy is possible, and further, the patient believes that she is sexually, anatomically and functionally intact—a factor of much greater importance than is usually believed. Such eminent authorities as Berkeley and Bonney support this view. The function of menstruation is maintained, thus possibly diminishing the severity of the menopausal symptoms.

Dangers. Intra-peritoneal oozing from the uterine wound may occur, resulting in a febrile convalescence and the formation of adhesions which may be a possible cause of intestinal obstruction. There is also the likelihood of bowel adhering to the sutured incision in the uterus. It is therefore of the greatest importance to obtain complete hæmostasis and to suture the uterine wound edges most accurately. Preferably the incision should be confined to the anterior wall of the uterus.

Fibroids in the posterior wall, unless large or subperitoneal, can usually be removed by traversing the uterine cavity from the anterior aspect of the uterus.

Indication. Myomectomy is the operation of choice in patients who have not yet reached the menopause.

Contra-indications. The presence of malignancy, a sloughing or infected myoma, a fibroid polypus protruding through the os and therefore presumably septic (this should be removed per vaginam), marked laceration, hypertrophy or infection of the cervix, or a cervical fibroid.

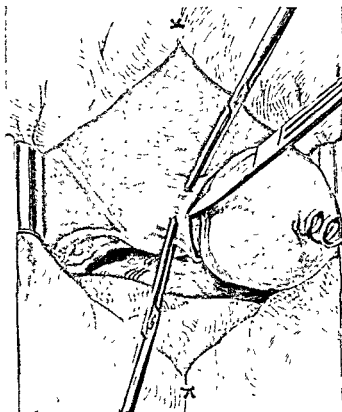


Fig. 1388.—**MIOMECTOMY FOR PEDUNCULATED FIBROID.** A PEDUNCULATED SUBSEROUS FIBROID IS REMOVED BY PULLING THE TUMOUR UPWARDS, CLAMPING THE PEDICLE ON EACH SIDE, AND THEN DIVIDING IT SOME DISTANCE ALONG THE CURVED FACE OF THE TUMOUR.

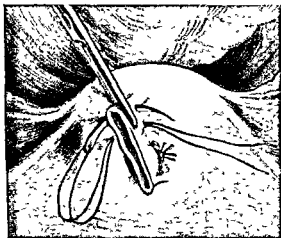


Fig. 1389.—**MIOMECTOMY FOR PEDUNCULATED FIBROID.** BLEEDING IS ARRESTED BY PASSING BLANKET STITCHES THROUGH THE BASE OF THE PEDICLE.

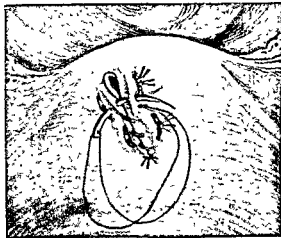


Fig. 1390.—**MIOMECTOMY FOR PEDUNCULATED FIBROID.** THE EDGES OF THE PEDICLE ARE INFOLDED WITH A CONTINUOUS CATGUT STITCH.

After the menopause hysterectomy is to be preferred to myomectomy. When fibroids and pregnancy occur together the patient should be allowed to proceed to term. If the fibroid is below the brim and obstructs labour, Cæsarean section will be necessary, and myomectomy may be performed at the same time. Myomectomy can be performed on the recently emptied uterus as readily and satisfactorily as on the non-pregnant uterus. In a case of red degeneration of a fibroid (usually occurring during pregnancy and attended by severe pain and marked pyrexia) every effort should be made to relieve pain and to tide the patient over until the child is viable, when Cæsarean section and myomectomy may be carried out together. Where, however, immediate surgical measures prove necessary, myomectomy can often be performed without interfering with the pregnancy.

Future Pregnancy. Conception is less likely to occur after myomectomy than in a normal uterus. The age-factor must, however, be borne in mind when making this comparison. After myomectomy there is little danger of rupture during delivery as the walls will have healed firmly.

MYOMECTOMY FOR A PEDUNCULATED FIBROID

Procedure. The fibroid is transfixed by the myomectomy screw and the attachment of its pedicle is examined. The uterus is then lifted well up and the myomectomy clamp is applied so as to include the round ligaments as well as the lower uterine segment. The clamp exerts firm pressure directly on the uterine arteries and other vessels entering below this level, and at the same time fixes and supports the uterus in an accessible position. The ovario-pelvic ligaments are now grasped with ring forceps or intestinal clamps. By this means the entire blood supply to the uterus is effectually controlled.

The peritoneum is incised round the base of the pedicle and the edges are retracted. The central portion of the pedicle is then crushed with artery forceps, divided, and the fibroid removed (fig. 1388). One or two mattress sutures of catgut on a No. 2 trocar-pointed needle are then passed so as to underrun the denuded area (fig. 1389). The cut edges are finally infolded by a continuous stitch of catgut on an intestinal needle (fig. 1390).

Alternative Procedure. When the pedicle is very small, it may be clamped close to the uterus and ligated with doubled catgut. When large and wide, it cannot be clamped and the peritoneum and possibly

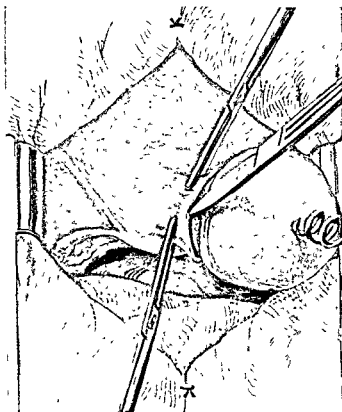


Fig. 1388.—**MYOMECTOMY FOR PEDUNCULATED FIBROID.** A PEDUNCULATED SUBSEROUS FIBROID IS REMOVED BY PULLING THE TUMOUR UPWARDS, CLAMPING THE PEDICLE ON EACH SIDE, AND THEN DIVIDING IT SOME DISTANCE ALONG THE CURVED FACE OF THE TUMOUR.

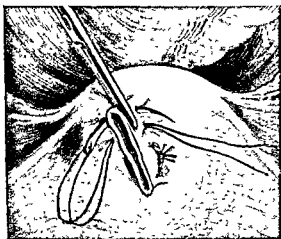


Fig. 1389.—**MYOMECTOMY FOR PEDUNCULATED FIBROID.** BLEEDING IS ABSTAINED BY PASSING BLANKET STITCHES THROUGH THE BASE OF THE PEDICLE.

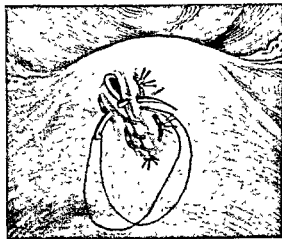


Fig. 1390.—**MYOMECTOMY FOR PEDUNCULATED FIBROID.** THE EDGES OF THE PEDICLE ARE INFOLDED WITH A CONTINUOUS CATGUT STITCH.

the capsule of the tumour must be incised and the fibroid enucleated. Hæmostasis is ensured by several deep underrunning mattress sutures, and the two flap edges are infolded with a continuous suture.

The uterine clamp and the forceps on the ovarian pedicles are removed, and the wound is carefully inspected for any sign of oozing, which must be arrested by passing further mattress sutures. The final appearance of the wound should be blanched.

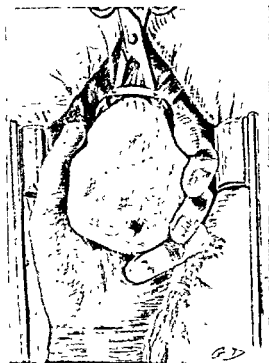


Fig. 1391.—MYOMECTOMY FOR NON-PEDUNCULATED FIBROIDS. THE EDGES OF THE ABDOMINAL INCISION HAVING BEEN COVERED WITH TOWELS AND MACKINTOSHES ARE NOW RETRACTED, THE UTERUS IS PULLED UPWARDS AND A BOSNEY MYOMECTOMY CLAMP IS FIXED SO AS TO GRASP THE SUPRA VAGINAL PORTION OF THE CERVIX, THE ROUND LIGAMENTS BEING INCLUDED WITHIN THE JAW. THE UTERINE VESSELS AND THOSE EXTENDING INTO THE UTERUS FROM THE VAGINA ARE BY THIS MEANS COMPRESSED, WHILST THE CLAMP HOLDS THE UTERUS UP AND STABILISES IT. THE UTERUS IS HERE THE SITE OF NUMEROUS SMALL MYOMATA.

MYOMECTOMY FOR NON-PEDUNCULATED FIBROMYOMATA

Procedure. The uterus is drawn up through the abdominal wound and carefully examined to determine the situation, size and number of the myomata. The myomectomy and ovario-pelvic ligament clamps are then applied (figs. 1391 and 1392).

Whenever myomectomy is performed, the cavity of the uterus

must be opened and carefully explored to exclude the presence of sub-mucous myomata, endometrial polypi, carcinoma, and, where necessary, to permit removal of the endometrium with the curette.

Wherever practicable, posteriorly-placed tumours should be approached through an incision in the anterior wall of the uterus (fig. 1393). Incisions in the uterus should be as few in number as the size and situation of the tumours will permit. Enucleation should be effected as far as possible by secondary incisions through the primary

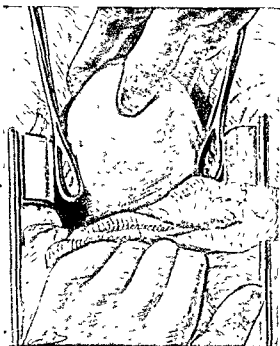


Fig. 1392.—MYOMECTOMY FOR NON-PEDUNCULATED FIBROIDS. THE UTERUS IS PULLED FORWARDS AND UPWARDS AND THE BROAD LIGAMENTS ARE CLAMPED WITH FORCEPS. A TOWEL IS BEING INSERTED WITH THE LEFT HAND TO SHUT OFF THE UPPER ABDOMEN.

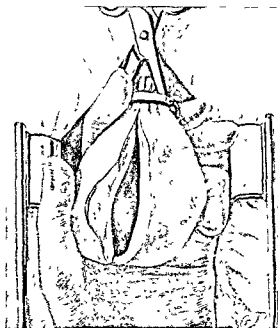


Fig. 1393.—MYOMECTOMY FOR NON-PEDUNCULATED FIBROIDS. THE ANTERIOR WALL OF THE UTERUS IS INCISED, THE UTERINE CAVITY IS DISPLACED AND SEVERAL FIBROIDS IN THE ANTERIOR AND POSTERIOR WALLS ARE EXPOSED.

opening (fig. 1394). Frequently, however, multiple incisions are unavoidable despite the most careful planning. When dividing the capsule, the scalpel should cut into the substance of the tumour to ensure exposure of the line of cleavage between it and the capsule.

The myomectomy screw can be inserted into the growth when it is sufficiently large (fig. 1395). Good control of the tumour is obtained and it can be twisted, rotated or levered, and finally stripped from its bed with the fingers or scissors. Tumours in the anterior wall of the uterus are dealt with successively until all have been removed.

When all the tumours in the anterior wall have been successfully dealt with, the uterine cavity is opened if this has not already been

done, and tumours in the posterior wall are cut down on and enucleated in the manner just described (fig. 1394). When tumours in the posterior wall are *very large or are lying just under the peritoneum*, it is better to remove them by a posterior incision.

All cavities are now obliterated by passing deep mattress sutures of catgut which should underrun the tumour bed, the cavities in the posterior wall being dealt with first (fig. 1394). When the cavity

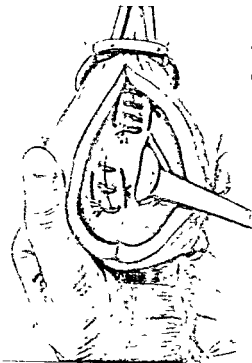


Fig. 1394.—MYOMECTOMY FOR NON-PEDICULATED FIBROIDS. TWO FIBROIDS HAVE BEEN REMOVED FROM THE POSTERIOR WALL OF THE UTERUS. THE SPACES LEFT HAVE BEEN OBLITERATED WITH BLANKET SUTURES, AND THE EDGES SUTURED. A SMALL MYOMA IS BEING ENUCLEATED WITH THE HANDLE OF A SCALPEL.

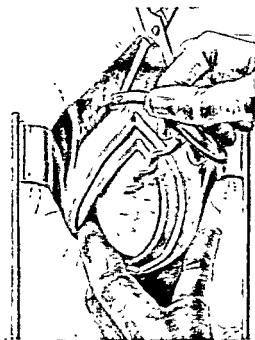


Fig. 1395.—MYOMECTOMY FOR NON-PEDICULATED FIBROIDS. REMOVING A MEDIUM-SIZED MYOMA FROM THE POSTERIOR UTERINE WALL. ACCESS HAS BEEN OBTAINED BY TRaversING THE ANTERIOR WALL AND THE CAVITY OF THE UTERUS. A MYOMECTOMY SCREW IS INSERTED INTO THE TUMOUR WHICH IS THEN PULLED UPWARDS WHILE THE FINGERS FREE IT FROM ITS CAPSULE.

is large, the walls may be sewn together from the bottom upwards. If the cavity is near the lateral aspect of the uterus, care must be taken not to puncture the uterine vessels; should this happen a hæmatoma will form in the broad ligament, and the bleeding will have to be arrested by a ligature on each side of the point of puncture, after which the clot must be turned out and the opening closed.

Before closing the incision in the anterior uterine wall, the uterus is thoroughly inspected and palpated, both externally and within its cavity, to determine whether any small seedling fibroids are present.

At this stage the endometrium is removed with a sharp scoop, the cornu being carefully explored, after which the interior of the uterus is swabbed with tincture of iodine. The uterine clamp is then slackened to allow circulation to return, and if any bleeding is noted it is arrested by passing further mattress stitches. The wound in the uterine wall is closed with mattress stitches of catgut (fig. 1396). These stitches pierce the muscle just superficial to the mucosa, thus bringing the deep surfaces of the incised uterine muscle on each side flush together.

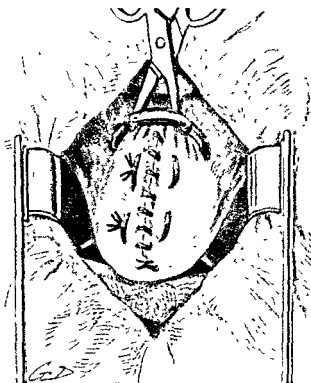


Fig. 1396.—MIOMECTOMY FOR NON PEDUNCULATED FIBROIDS. THE INCISION IN THE ANTERIOR UTERINE WALL IS CLOSED WITH TWO BLANKET STITCHES AND THE EDGES ARE UNITED BY A CONTINUOUS SUTURE OF CATGUT.

Finally, the edges of the peritoneum are approximated and infolded by a continuous stitch of fine catgut on an intestinal needle, and any other incisions that have been made are sutured in a similar manner.

The uterine and broad ligament clamps are now removed, the uterus is finally inspected for any oozing, which is arrested by inserting further mattress stitches, and the pelvic cavity is wiped dry.

As the uterus in most cases is large, heavy, and tends to fall back into the hollow of the sacrum, ventro-fixation should be performed (fig. 1397). Shortening the round ligaments after the manner of a modified Gilliam operation may on occasions suffice when there is only

one incision in the anterior uterine wall. But if there is a tendency for oozing to take place from this surface, ventro-fixation by direct suture is to be preferred.

Should there be a tendency for slight oozing to occur despite all stitching, a drainage-tube should be left in the pouch of Douglas to prevent the formation of a hæmatoma. The tube must be removed in 48 hours.

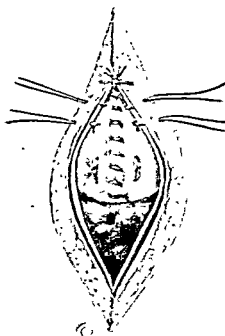


Fig. 1397.—MYOMECTOMY FOR NON-PEDUNCULATED FIBROIDS. THE UTERUS IS VENTRO-FIXED BY STITCHING THE LOWER PART OF THE ANTERIOR SURFACE OF THE UTERUS TO THE ANTERIOR ABDOMINAL WALL IN THE MANNER HERE DEPICTED.

Difficulties and Dangers. These have been greatly minimised by the adoption of the Bonney myomectomy clamp as by its use, together with the application of ring forceps or intestinal clamps to the ovarian vessels, complete hæmostasis is effected and the surgeon can take his time and plan the operation with deliberation. The operation should never be undertaken in the presence of sepsis. The chief danger is that of oozing, but careful suture, and possibly drainage, will reduce this to a minimum.

Myomectomy on the whole can be said to be a safe and useful operation, and recurrence is most unlikely if the cavity and the wall of the uterus have been carefully explored to ensure that no seedling fibroids remain.

RADICAL HYSTERO-COLPECTOMY FOR CARCINOMA OF THE CERVIX (Wertheim's Operation)

Cystoscopic examination is made and large ureteric bougies or catheters are passed well up into the ureters above the pelvic brim. The vagina is then tightly packed, first with a small piece of gauze soaked in 10 per cent picric acid in absolute alcohol, this being pressed closely against the growth, and secondly with a large roll of gauze soaked in antiseptic solution; the second pack is removed at a late stage in the operation.

The object of packing is to sterilise the vagina and growth as far as possible, to prevent further oozing, and to distend the vagina firmly so as to facilitate its separation from the surrounding tissues. The small pack remains against the cervix and prevents scattering of cancer cells along the vagina when the larger pack is removed.

Procedure. A long abdominal incision is required and the wound edges must be protected with special care.

Artery forceps placed on the broad ligament on each side of the uterus are used to pull it upwards, and the ovario-pelvic and round ligaments are underrun with catgut and tied as far out as possible (fig. 1398). The structures are then cut and the broad ligament is divided down to the level of the internal os.

A long catgut stitch is now passed through each side of the uterus so as to include the uterine vessels and is then tied. The tube and ovary are folded up and included in each stitch, the ends of which are left long and used as tractors. The artery forceps previously placed on the broad ligament are then removed (fig. 1399).

The peritoneal reflection from the upper surface of the bladder on to the uterus is cut across and carried out as far as the incision into the broad ligament on each side. The free edge is caught with forceps, pulled upwards and temporarily stitched to the lower end of the abdominal wound, while at the same time the bladder is separated from the lower uterine segment and the upper part of the vagina by

use dissection, aided by a few dainty touches with the knife at adherent points (fig. 1400). This separation will reveal any invasion of the bladder by direct extension of the growth through the anterior vaginal fornix and cervical wall. When invasion is demonstrated it is useless to proceed with the operation.

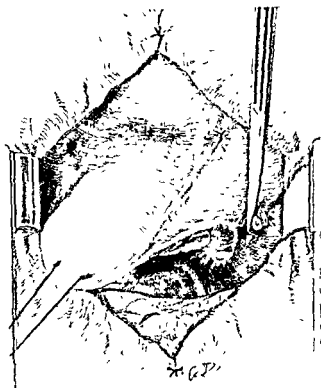


Fig. 1398.—RADICAL HYSTERO-COLPECTOMY. THE EDGES OF THE ABDOMINAL WOUND ARE COVERED WITH MACKINTOSH SQUARES AND TOWELS, AND RETRACTED. THE COVERS ARE SECURED ABOVE AND BELOW WITH STITCHES. THE GENERAL PERITONEAL CAVITY IS ALSO PACKED OFF WITH WET SOFT TURKISH TOWELS. THE UTERUS IS LIFTED UP WITH A LARGE RECTOR SUTURE, THE ROUND LIGAMENTS ARE UNDERRUN AND TIED WITH CATGUT, AND THE OVARIO-PELVIC LIGAMENT ON THE RIGHT SIDE IS TIED IN THE SAME MANNER. AS THE UTERUS IS BEING PULLED UPWARDS AND TO THE LEFT, THE RIGHT OVARIO-PELVIC AND BROAD LIGAMENTS ARE DIVIDED WITH A SCALPEL.

Too extensive separation, especially of the sides of the vagina, should, however, be avoided at this stage lest para-vaginal veins and sub-vesical vessels be torn and produce troublesome oozing.

The broad ligament is next opened up and the ureters and the uterine arteries are identified (fig. 1401). The tips of the index fingers are inserted between the two layers of the basal part of the broad ligament on each side and separated. The ureter as it passes under the posterior edge is exposed and cleared for about $\frac{1}{2}$ inch by blunt

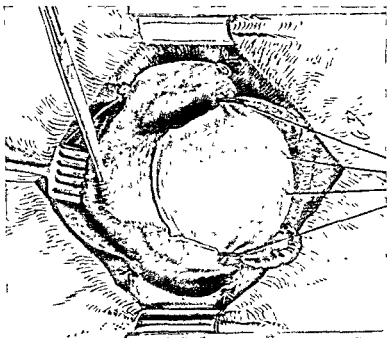


Fig. 1400.—Radical Hysterectomy. The Uterus is pulled upwards by the tractor stitches. The Ovario-pelvic and Round Ligaments on each side have been tied and cut; the Broad Ligaments have been divided, the Peritoneum has been incised at the level of loose reflection from the front of the Uterus, and together with the underlying Bladder has been retracted downwards. By a few light strokes with the Scalpel the Bladder is being freed from the anterior aspect of the upper part of the Vagina which is rendered taut by traction upwards on the Uterus. The Uterine Vessels and the Left Ureter are dimly outlined.

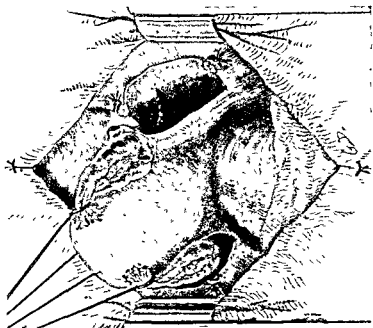


Fig. 1399.—Radical Hysterectomy. The Ovario-pelvic, Broad and Round Ligaments on both sides are divided down to the level of the Uterine Vessels. A large tractor stitch has been passed through the Uterus on each side, securing the Uterine Vessels and infolding the Tubes and Ovaries. On the right side of the Uterus running laterally the outline of the right Uterine Vessels can be seen. The Uterus being pulled upwards and to the left, the right Uterine sacral Ligament is rendered taut and can be seen curving around the right side of the Rectum which lies in the centre foreground.

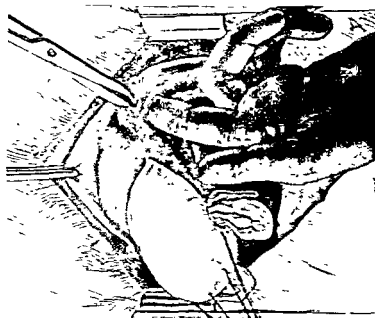


Fig. 1401. - Radical Hysterectomy. Securing the Uterine Vessels. The uterus being lifted upwards and to the left, the index finger of the left hand is passed along the right "Uterine Canal" in the connective tissue at the base of the broad ligament, the finger being in front of the uterus, under the uterine vessels, and the tip is then moved upwards on the ligament, dissection is made through the loose tissue with the point of the scissors so that a window is made above the vessels.

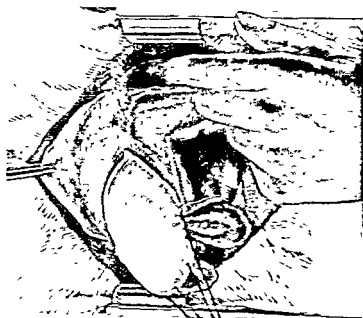


Fig. 1402. - Radical Hysterectomy. Opening of the Right Broad Ligament. The posterior lap of the right broad ligament is drawn backward and blunt dissection is made with the finger through the loose connective tissue, exposing the right Uterine and Right Uterine Vessels. The finger is applied in cutting upwards on the uterus and by drawing the cut edge of the peritoneum towards the uterus.

dissection, so that the uterine artery can be seen and felt crossing along its upper surface.

A finger is then passed along the "ureteric canal" (the space in the connective tissues at the base of the broad ligament) under the uterine artery, the tip coming to the surface near the entrance of the ureter into the bladder and being exposed by a little blunt dissection (fig. 1402). In this way a passage is provided under the artery and above the ureter.

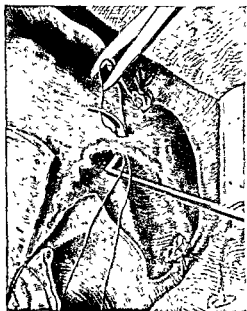


Fig. 1403. — RADICAL HYSTERO-COLPECTOMY. SECURING THE UTERINE VESSELS. A DOUBLE LIGATURE OF CATGUT ON AN ANEURYSM NEEDLE IS PASSED THROUGH THE CHANNEL PREVIOUSLY MADE, THE LOOP IS DIVIDED, AND THE ENDS ARE SECURED.

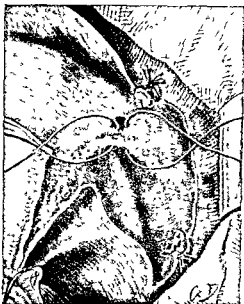


Fig. 1404. — RADICAL HYSTERO-COLPECTOMY. TRACTION IS MADE MEDIAL AND LATERALLY ON THE TWO LOOPS OF CATGUT PRIOR TO LIGATURE OF THE UTERINE VESSELS

An aneurysm needle is passed through this channel carrying a strand of catgut which is pulled through in a long loop and cut as the needle is withdrawn, thus forming two ligatures (fig. 1403). These are separated and tied (fig. 1404) in order to secure the uterine vessels at two points, one near the uterus and the other lateral to the ureter. The uterine vessels are divided between the ligatures which are then cut short (fig. 1405).

The same procedure is repeated on the other side.

Each ureter is now separated from its bed down to its entrance into the bladder, and this can be aided by passing a ligature deep to the ureter and using it as a retractor (fig. 1406). When both ureters have been thus separated the bladder is further stripped from the front of

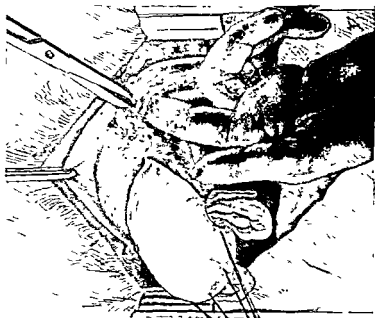


Fig. 1402.—RADICAL HYSTERIO COLPECTOMY. SECURING THE UTERINE VESSELS. THE UTERUS BEING TILTED UPWARD AND TO THE LEFT, THE INDEX FINGER OF THE LEFT HAND IS PASSED ALONG THE RIGHT "UTERINE CANAL" IN THE CONNECTIVE TISSUE AT THE BASE OF THE RIGHT BROAD LIGAMENT; THE FINGER PASSES IN FRONT OF THE UTERUS UNDER THE UTERINE VESSELS AND THE TIP IS THEN CURVED UPWARD ON THE BLADDER SIDE. DISSECTION IS MADE THROUGH THE LOOSE TISSUE WITH THE POINT OF THE SCISSORS SO THAT A LAMELLAE IS MADE AROUND THE VESSELS.

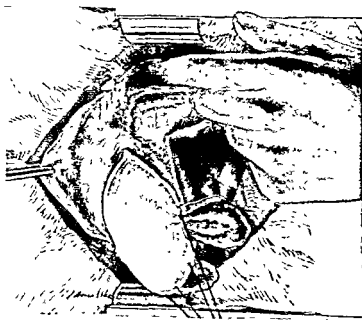


Fig. 1401.—RADICAL HYSTERIO COLPECTOMY. OPENING UP THE RIGHT BROAD LIGAMENT. THE POSTERIOR LEAF OF THE RIGHT BROAD LIGAMENT IS DRAWN BACKWARD AND BLUNT DISSECTION IS MADE WITH THE FINGERS THROUGH THE LOOSE CONNECTIVE TISSUE, EXPOSING THE RIGHT URETER AND RIGHT UTERINE VESSELS. THE PROCEDURE IS ASSISTED BY PULLING UPWARD ON THE UTERUS AND BY DRAWING THE CUT EDGE OF THE PERITONEUM TOWARD THE SYMPHYSIS.

dissection, so that the uterine artery can be seen and felt crossing along its upper surface.

A finger is then passed along the "ureteric canal" (the space in the connective tissues at the base of the broad ligament) under the uterine artery, the tip coming to the surface near the entrance of the ureter into the bladder and being exposed by a little blunt dissection (fig. 1402). In this way a passage is provided under the artery and above the ureter.

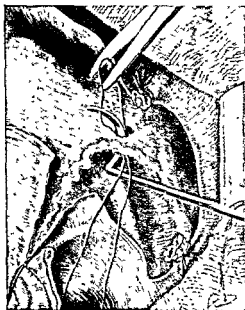


Fig. 1403. — RADICAL HYSTERO-COLPECTOMY. SECURING THE UTERINE VESSELS. A DOUBLE LIGATURE OF CATGUT ON AN ANEURYSM NEEDLE IS PASSED THROUGH THE CHANNEL PREVIOUSLY MADE, THE LOOP IS DIVIDED, AND THE ENDS ARE SECURED.

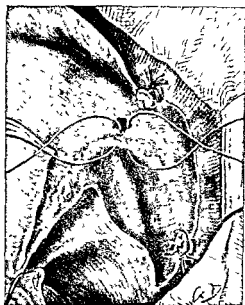


Fig. 1404. — RADICAL HYSTERO-COLPECTOMY. TRACTION IS MADE MEDIAL AND LATERALLY ON THE TWO LOOPS OF CATGUT PRIOR TO LIGATURE OF THE UTERINE VESSELS.

An aneurysm needle is passed through this channel carrying a strand of catgut which is pulled through in a long loop and cut as the needle is withdrawn, thus forming two ligatures (fig. 1403). These are separated and tied (fig. 1404) in order to secure the uterine vessels at two points, one near the uterus and the other lateral to the ureter. The uterine vessels are divided between the ligatures which are then cut short (fig. 1405).

The same procedure is repeated on the other side.

Each ureter is now separated from its bed down to its entrance into the bladder, and this can be aided by passing a ligature deep to the ureter and using it as a retractor (fig. 1406). When both ureters have been thus separated the bladder is further stripped from the front of

the vagina by gauze and scissor dissection. As the bladder is being separated it should be pushed downwards with the special retractor (see fig. 1347).

This separation may be somewhat difficult in the angle between the ureter and bladder and considerable oozing is liable to occur.

The uterus is next drawn upwards and towards the pubes and a fold of peritoneum in the mid-line at the bottom of the pouch of Douglas is picked up with Allis forceps and divided, to expose the plane of cleavage between the rectum and vagina (fig. 1407). By movement of



Fig 1405.—RADICAL HYSTERO-COLLECTOMY.
EACH LOOP OF CATGUT IS TIED, SECURING THE
RIGHT UTERINE VESSELS WHICH ARE DIVIDED
BETWEEN THE LIGATURES.

the fingers passed into this space and by pressing against the back of the vagina, the rectum is steadily stripped off as far down as the lower third of the vagina (fig. 1408) which is further isolated posteriorly and laterally by separation of loose tissues with the index fingers.

The pull on the uterus upwards and towards the pubes is continued, and the utero-sacral ligaments on each side are clamped and cut, as far away from the uterus as possible, care being taken not to injure the ureters or the sides of the rectum (fig. 1409).

The transverse cervical (cervico-pelvic) ligaments are isolated on each side by passing the finger around the lateral aspect of the vagina from behind as low down as possible, and then by dissecting upwards. They are clamped and cut far out (fig. 1410). This frees the uterus and

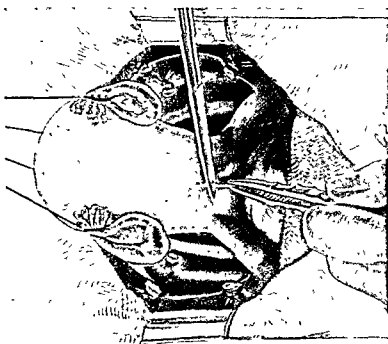


Fig. 1407.—Radical Hysterectomy. Separating the uterus from the posterior aspect of the vagina. The uterus is pulled upward and towards the symphysis and a fold of peritoneum in the bottom of the Pouch of Douglas is lifted with forceps and divided. The exposed Uterine Arteries are seen on each side.

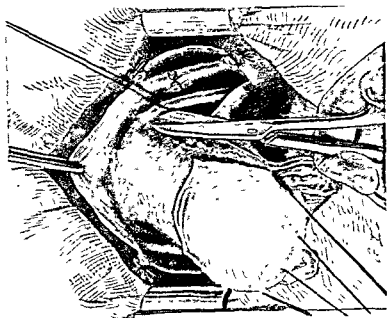


Fig. 1406.—Radical Hysterectomy. Separating the right Ureter from its channel in the connective tissue at the base of the right Broad Ligament and from the anterolateral aspect of the vagina. The Ureter has been underlain with a loop of catgut, and gentle traction is made upward and to the right, and dissection is effected by a few careful snips with the scissors.

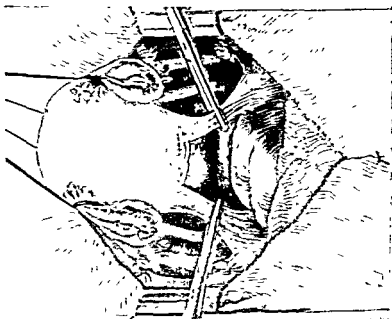


Fig. 1400.—Radical Hysterectomy, Clamping the Uterine Ligaments. These are rendered taut by pulling the uterus upward and toward the cervix. They are then clamped as far away from the uterus as possible.

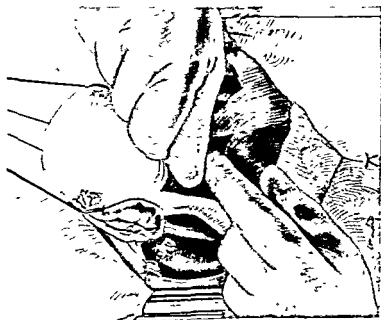


Fig. 1401.—Radical Hysterectomy, Separation of the Uterus from the Posterior Aspect of the Vagina. Traction on the uterus is maintained and the uterine artery of the vagina is pushed forward with the right thumb, while the left index finger presses the rectum backward and shifts it off the vagina by movement from side to side.

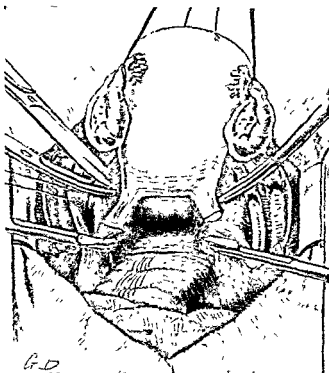


Fig. 1410.—RADICAL HYSTERO-COLPECTOMY. CLAMPING AND DIVIDING THE CERVICO-PELVIC LIGAMENTS. THE LEFT CERVICO-PELVIC LIGAMENT IS BEING DIVIDED WITH SCISSORS NEAR TO THE CLAMP, THE LEFT URETER BEING GENTLY HELD OUT OF THE WAY WITH A CATGUT LOOP WHICH SERVES AS A TRACTOR.

upper part of the vagina, allowing a considerable increase in upward movement. The bladder is now further stripped from the vagina down to the pelvic floor by pulling it towards the pubes with the broad retractor, while the uterus is being drawn upwards and towards the umbilicus.

At this stage the large vaginal pack is removed, leaving the small one against the cervix. The bladder is retracted towards the pubes and, the ureters being kept well in sight, the Bonney clamp (fig. 1411) is applied across the vagina at the junction of its lower and middle thirds. A large swab is now placed deep down in front of the

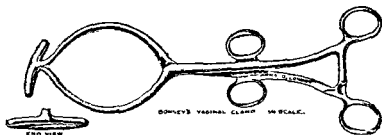


Fig. 1411.—BONNEY'S VAGINAL CLAMP. THIS IS USED TO GRASP THE FREE VAGINA BELOW THE CERVIX WHEN PERFORMING RADICAL HYSTERO-COLPECTOMY.

rectum and the vagina is cut across below the clamp (fig. 1412). In this way the cervical growth is removed enclosed in the upper part of the vagina.

The bladder being drawn well forwards, the angles of the vagina are picked up with Allis forceps (fig. 1413), and the opening is sutured with a double strand of catgut (fig. 1414).

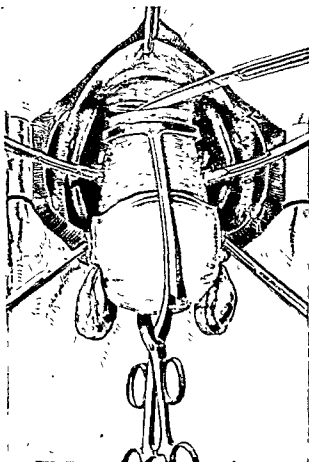


Fig 1412.—RADICAL HYSTERO-COLPECTOMY. CLAMPING AND DIVIDING THE VAGINA. THE FOUR CLAMPS ARE STILL APPLIED TO THE UTERO-SACRAL AND TO THE CERVICO-PELVIC LIGAMENTS, THE URETERS ARE FULLY EXPOSED ON EACH SIDE AS THEY COURSE FORWARDS AND THE BLADDER IS RETRACTED TOWARDS THE SYMPHYSIS. THE BONNEY CLAMP IS APPLIED TO THE VAGINA FAR BELOW THE CERVIX, GENTLE TRACTION IS MADE ON THE CLAMP, AND THE VAGINA IS DIVIDED NEAR THE PELVIC FLOOR.

Considerable bleeding occurs from the lateral vaginal angles and must be arrested by blanket stitches. The clamped utero-sacral and transverse cervical ligaments are tied and any oozing vessels are picked up with forceps and ligated.

Glands which are liable to invasion by malignant cells are removed

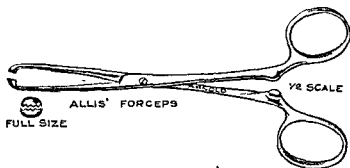


Fig. 1413.—ALLIS' FORCEPS. THESE ARE USED FOR HOLDING THE CUT EDGES OF THE SKIN, PERITONEUM AND VAGINAL WALL.

by dissecting *en bloc* the cellular tissues and the chains of glands along the external iliac vessels, from the bifurcation of the common iliac arteries down into the obturator fossa (fig. 1415). Blunt dissection should begin on the outer side of the vessels and be carried downwards and inwards. Care must be taken to avoid injuring the external iliac veins, especially when enlarged glands are present.

The obturator nerve, as it runs along the lower part of the lateral pelvic wall, should be isolated from this loose mass of tissues and glands

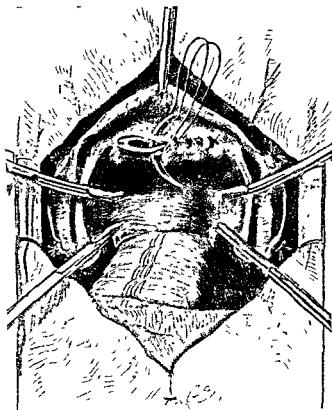


Fig. 1414.—RADICAL HYSTERO-COLECTOMY. THE DIVIDED END OF THE VAGINA IS CLOSED BY A CONTINUOUS STITCH OF CATGUT WHICH PENETRATES THE ENTIRE THICKNESS OF ITS WALL. THE INTRA-PERITONEAL PORTION OF THE RECTUM CAN BE SEEN.

and preserved. This mass of tissues, which is possibly invaded with malignant cells, is clamped at its upper and lower ends and cut away (fig. 1416). The lower clamp will contain the obliterated hypogastric artery, and the upper clamp that anterior branch of the internal iliac artery which divides into the uterine and obliterated hypogastric arteries. This anterior branch of the internal iliac artery is a large vessel and should be carefully secured.

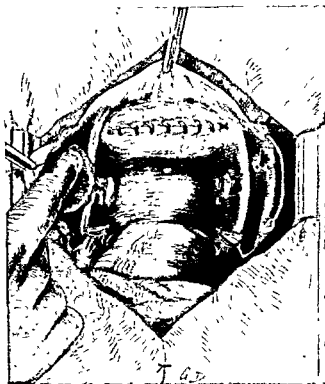


Fig. 1415.—RADICAL HYSTERO-COLECTOMY. REMOVAL OF THE ILLAC AND OBTURATOR LYMPHATIC GLANDS. THE VAGINAL STUMP HAS BEEN CLOSED, AND THE UTERO-SACRAL AND CERVICO-PELVIC LIGAMENTS HAVE BEEN TIED. THE EDGE OF THE DIVIDED PERITONEUM OVER THE EXTERNAL ILLAC VESSELS IS PULLED UPWARDS AND LATEROALLY. THE CONNECTIVE TISSUE AND LYMPHATIC GLANDS ALONG THESE VESSELS ARE STRIPPED UPWARDS AND DOWNWARDS AND ARE THEN PEELED OFF MEDIOALLY SO AS TO CLEAR THE GLANDS AND CONNECTIVE TISSUE FROM THE OBTURATOR FOSSA.

There are two large veins which are liable to be injured during the removal of the glands and connective tissues, namely, the obturator and the internal iliac.

It is important to arrest all oozing, and this part of the operation occasionally consumes much valuable time.

The raw area at the bottom of the pelvis is now covered by suturing the anterior and posterior edges of the peritoneum with a continuous

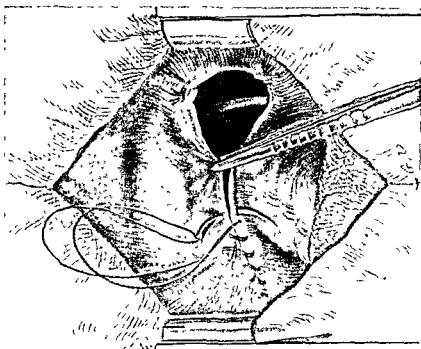


Fig. 1417.—RADICAL HYSTERO-COLECTECTOMY. REPERITONISATION OF THE PELVIS. THE ANTERIOR EDGE OF THE PERITONEUM IS NOW UNITED TO THE POSTERIOR BY A CONTINUOUS STITCH FROM SIDE TO SIDE. THE RIGHT UTERUS AND ITS CLOSE ATTACHMENT TO THE POSTERIOR LAYER OF PERITONEUM NEAR THE TIED OVARIAN VESSELS CAN BE SEEN.

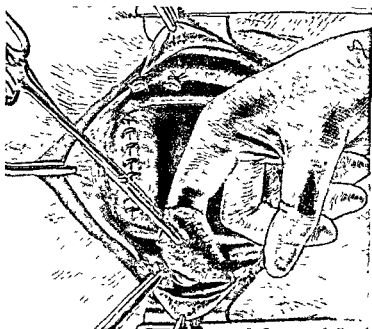


Fig. 1418.—RADICAL HYSTERO-COLECTECTOMY. REMOVAL OF GLANDS. THE GLANDS AND CONNECTIVE TISSUE ON THE EXTERNAL ILIAC VESSELS AND IN THE OBTURATOR FOSSA HAVING BEEN STRIPPED FREE, THE OBLITERATED ILLIO-POAS ARTERY BELOW IS CLAMPED AND CUT, AND THE MASS OF LOOSE TISSUE IS STRIPPED UPWARDS. THE UPPER EXTREMITY OF THE ISOLATED MASS OF TISSUE AND GLANDS WILL NOW BE CLAMPED SO AS TO INCLUDE THE UTERINE ARTERY AS IT ARISES FROM THE INTERNAL ILIAC ARTERY. THE OBTURATOR NERVE, THE INTERNAL ILIAC ARTERY AND THE UTERUS CAN BE SEEN ON EACH SIDE.

and preserved. This mass of tissues, which is possibly invaded with malignant cells, is clamped at its upper and lower ends and cut away (fig. 1416). The lower clamp will contain the obliterated hypogastric artery, and the upper clamp that anterior branch of the internal iliac artery which divides into the uterine and obliterated hypogastric arteries. This anterior branch of the internal iliac artery is a large vessel and should be carefully secured.

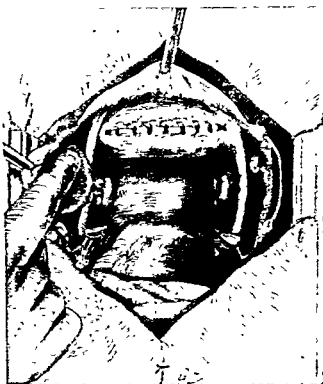


FIG. 1416.—RADICAL HYSTERO-COLECTOMY. REMOVAL OF THE ILLIC AND OBTURATOR LYMPHATIC GLANDS. THE VAGINAL STUMP HAS BEEN CLOSED, AND THE UTERO-SACRAL AND CERVICO-PELVIC LIGAMENTS HAVE BEEN TIED. THE EDGE OF THE DIVIDED PERITONEUM OVER THE EXTERNAL ILLIC VESSELS IS PULLED UPWARDS AND LATEROALLY. THE CONNECTIVE TISSUE AND LYMPHATIC GLANDS ALONG THESE VESSELS ARE STRIPPED UPWARDS AND DOWNWARDS AND ARE THEN PEELLED OFF MEDIANLY SO AS TO CLEAR THE GLANDS AND CONNECTIVE TISSUE FROM THE OBTURATOR FOSSA.

There are two large veins which are liable to be injured during the removal of the glands and connective tissues, namely, the obturator and the internal iliac.

It is important to arrest all oozing, and this part of the operation occasionally consumes much valuable time.

The raw area at the bottom of the pelvis is now covered by suturing the anterior and posterior edges of the peritoneum with a continuous

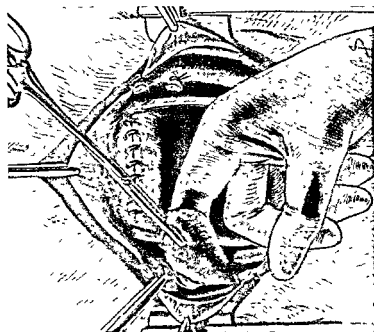


Fig. 1416.—Radical Hysterectomy. Removal of Glands. The glands and connective tissue on the external iliac vessels and in the obturator fossa having been stripped free, the obliterated hypogastric artery below is clamped and cut, and the mass of loose tissue is stripped upwards. The upper extremity of the isolated mass of tissue and glands will now be clamped so as to include the uterine artery as it arises from the internal iliac artery. The obturator nerve, the internal iliac artery and the ureter can be seen on each side.

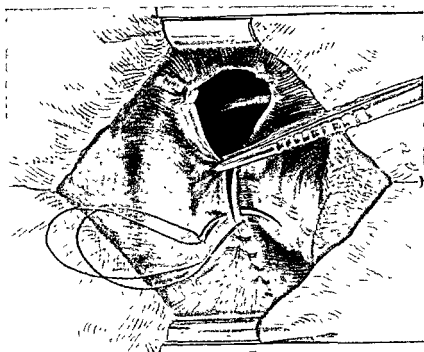


Fig. 1417.—Radical Hysterectomy. Reperitonisation of the Pelvis. The anterior edge of the peritoneum is now united to the posterior by a continuous stitch from side to side. The right umbilic and its close attachment to the posterior layer of paritoneum near the tied ovarian vessels can be seen.

stitch (fig. 1417). The suture line runs transversely across the pelvis, beginning in the neighbourhood of the left ovarian vessels. As the ureter is attached to the deep surface of the posterior flap of peritoneum on each side, its exact position must be constantly watched to avoid puncture or inclusion in the stitch.

The ureteric bougies are removed before the abdomen is closed, their easy withdrawal ensuring that the ureter has not been included in a ligature or stitch.

Recently it has been my practice at times to perform presacral neurectomy before closing the abdomen, so that in case of recurrence pain may be minimised. If on abdominal exploration the case is found to be inoperable, the presacral nerve should be excised.

No special vaginal after-treatment is required, as the suture line of the canal lies almost at the level of the vulva. This is cleansed several times daily and covered with a sterile pad.

Dangers of Wertheim's Operation

(1) *Injury to the Ureters.* The ureters may be crushed or be partially or completely cut, during the securing of the uterine vessels; they may be injured when the parametric tissues are clamped, or as the result of retraction; they may be pierced or included in the stitch during reperitonisation of the raw area; or they may slough as the result of too extensive separation from the peritoneum.

(2) *Injury to the Bladder* may result during its separation, especially if permeation with growth has taken place. A permanent fistula is likely to follow.

(3) *Injury to the Rectum* may occur during its separation from the vagina. The risk is greatly increased if there is any infiltration with growth.

(4) *Loss of Blood* through venous hæmorrhage from deep vessels in the para-vaginal and parametric tissues.

Post-Operative Complications

(1) *Shock* is likely to be severe following this operation, especially if prolonged for more than an hour.

(2) *Hæmorrhage from venous oozing.* This should be avoided by meticulous hæmostasis and careful securing of large bleeding veins, especially in the para-vaginal tissues.

(3) *Retention of urine* occurs in most cases, but normal function is usually restored by the end of the first week. Cystitis occasionally follows, chiefly as the result of sepsis introduced during catheterisation.

(4) *Incontinence of urine* is due to injury to the bladder or ureter.

(5) *Pelvic cellulitis* is rare. Abscess formation is apt to result, requiring drainage.

(6) *Peritonitis* is very unusual, but when it occurs it is liable to terminate fatally.

(7) *Ileus* is always present to some degree, but is seldom fatal.

(8) *Acute dilatation of the stomach* is a rare sequel, but the possibility of its occurrence must always be borne in mind.

Mortality. Bonney, who has brought Wertheim's operation to a very high standard and who performs this operation with exquisite skill, reports a 10 per cent operative mortality out of his list of 200 operations.

Results of the Operation. Bonney reports that of all patients operated upon, 40 per cent were cancer-free for five years, and 33½ per cent were free for ten years. Of all patients examined, 25 per cent were free for five years and 20 per cent were free for ten years. His operability-rate was 63 per cent of all cases seen.

Glandular involvement is important as far as prognosis is concerned.

Bonney's five-year cure-rate, where there was no secondary involvement of glands, was over 50 per cent; where there was gland invasion, 20 per cent.

FORWARD SUSPENSION OF THE UTERUS BY SHORTENING THE ROUND LIGAMENTS (Gilliam's Operation)

Indication. This operation is indicated in women of child-bearing age in the presence of retroversion of the uterus associated with back-ache and dyspareunia, uncomplicated by pelvic inflammation or the presence of fibroids.

Advantages. The uterus remains freely mobile in the normal position, and there is no added risk of complications during pregnancy and labour.

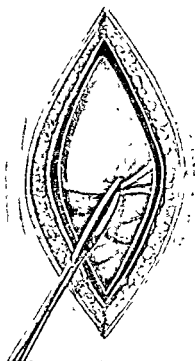


Fig. 1418.—GILLIAM'S OPERATION. THE ROUND LIGAMENT IS SECURED ABOUT HALF AN INCH LATERAL TO THE UTERUS.

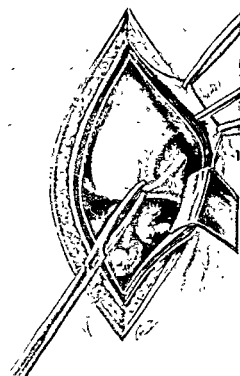


Fig. 1419.—GILLIAM'S OPERATION. THE ROUND-LIGAMENT FORCEPS ARE PASSED UNDER THE RECTUS SHEATH, OVER THE TOP OF, AND THEN LATERAL TO, THE RECTUS MUSCLE AND DOWNWARDS OUTSIDE THE PERITONEUM AND PARALLEL TO THE ROUND LIGAMENT, WHICH IS DRAWN TIGHT WITH THE FORCEPS.

It should be emphasised that the round ligaments are not sufficiently strong to maintain the uterus in a forward position when there is a tendency to backward displacement as the result of pelvic inflammation or of excessive weight, as in the case of a bulky uterus left after myomectomy.

Procedure. As the opening need not be large, a transverse incision may be used. If a vertical incision is made, it should not exceed $2\frac{1}{2}$ –3 inches in length.

Covering of the wound edges, insertion of the retractor, and the exclusion of the upper abdomen with a wet towel are unnecessary.

The uterus is lifted forwards from the pouch of Douglas and, together with the tubes and ovaries, is carefully examined, and the round ligament on each side is picked up with a pair of Allis forceps about $\frac{1}{2}$ inch from the uterus (fig. 1418).

The cut edge of the rectus sheath is picked up with forceps about 2 inches above the symphysis and is separated by blunt dissection from the front of the rectus muscle, vertically for about 2 inches and laterally to its outer border. The special round-ligament forceps are passed into this opening and worked down to the inguinal canal where the exit of the round ligament is reached. The direction is then altered so that the forceps pass parallel to the ligament but outside the peritoneum (fig. 1419). About 1 inch from the uterus the peritoneum is nicked over the tip of the forceps which now enter the peritoneal cavity and grasp a loop of round ligament (fig. 1420). When the forceps are withdrawn a loop of round ligament appears outside the rectus muscle. This portion of the round ligament is now sewn with catgut to the deep surface of the rectus sheath about 1 inch above the internal inguinal ring. Two or three turns of the stitch are used to make the attachment secure (fig. 1421).

The same procedure is carried out on the opposite side. By this

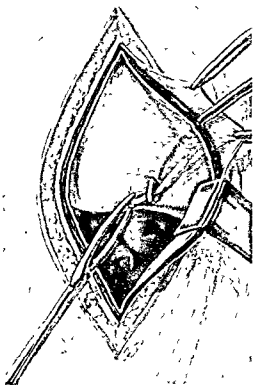


Fig 1420.—GILLIAM'S OPERATION. THE ROUND-LIGAMENT FORCEPS HAVE EMERGED THROUGH THE PERITONEUM AND SECURED THE ROUND LIGAMENT ABOUT AN INCH LATERAL TO ITS ATTACHMENT TO THE UTERUS.

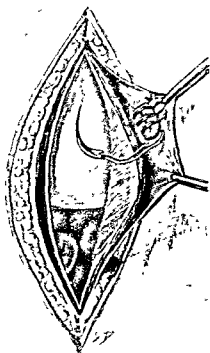


Fig. 1421.—GILLIAM'S OPERATION. THE LOOP OF THE ROUND LIGAMENT HAS BEEN DRAWN BACKWARDS THROUGH THE OPENING IN THE PERITONEUM AROUND THE LATERAL EDGE OF THE RECTUS MUSCLE AND IS SUTURED TO THE DEEP ASPECT OF THE RECTUS SHEATH NEAR THE INTERNAL INGUINAL RING.

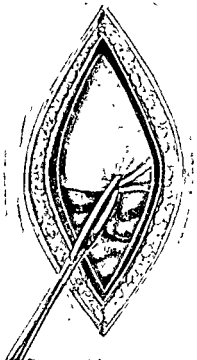


Fig. 1418.—GILLIAM'S OPERATION. THE ROUND LIGAMENT IS SECURED ABOUT HALF AN INCH LATERAL TO THE UTERUS.

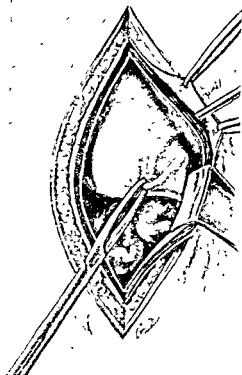


Fig. 1419.—GILLIAM'S OPERATION. THE ROUND-LIGAMENT FORCEPS ARE PASSED UNDER THE RECTUS SHEATH, OVER THE TOP OF, AND THEN LATERAL TO, THE RECTUS MUSCLE AND DOWNWARDS OUTSIDE THE PERITONEUM AND PARALLEL TO THE ROUND LIGAMENT, WHICH IS DRAWN TAUT WITH THE FORCEPS.

It should be emphasised that the round ligaments are not sufficiently strong to maintain the uterus in a forward position when there is a tendency to backward displacement as the result of pelvic inflammation or of excessive weight, as in the case of a bulky uterus left after myomectomy.

Procedure. As the opening need not be large, a transverse incision may be used. If a vertical incision is made, it should not exceed $2\frac{1}{2}$ –3 inches in length.

Covering of the wound edges, insertion of the retractor, and the exclusion of the upper abdomen with a wet towel are unnecessary.

The uterus is lifted forwards from the pouch of Douglas and, together with the tubes and ovaries, is carefully examined, and the round ligament on each side is picked up with a pair of Allis forceps about $\frac{1}{2}$ inch from the uterus (fig. 1418).

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The same procedure is carried out on the opposite side. By this

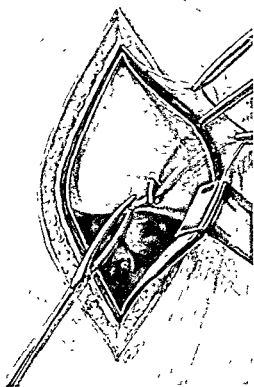


Fig. 1420.—GILLIAM'S OPERATION. THE ROUND-LIGAMENT FORCEPS HAVE EMERGED THROUGH THE PERITONEUM AND SECURED THE ROUND LIGAMENT ABOUT AN INCH LATERAL TO ITS ATTACHMENT TO THE UTERUS.

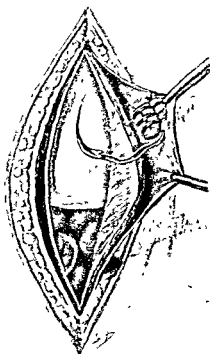


Fig. 1421.—GILLIAM'S OPERATION. THE LOOP OF THE ROUND LIGAMENT HAS BEEN DRAWN BACKWARDS THROUGH THE OPENING IN THE PERITONEUM AROUND THE LATERAL EDGE OF THE RECTUS MUSCLE AND IS SUTURED TO THE DEEP ASPECT OF THE RECTUS SHEATH NEAR THE INTERNAL INGUINAL RING.

The abdominal incision need not be more than 3 inches long, and the side towels, retractor, and pack to exclude the upper abdominal cavity are not necessary if the operation is performed solely for ventro-fixation.

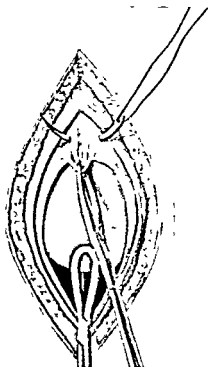


Fig. 1422.—VENTRO-FIXATION OF THE UTERUS. THE PARIETAL PERITONEUM AT THE LOWER ANGLE OF THE OPENING IS STITCHED TO THE FRONT OF THE SUPRA VAGINAL CERVIX AT THE LEVEL OF THE LOOSE REFLECTION OF THE PERITONEUM ON TO THE BLADDER.

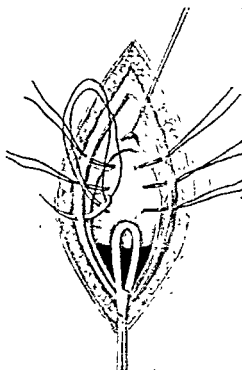


Fig. 1423.—VENTRO-FIXATION OF THE UTERUS. THREE FIXATION STITCHES ARE PASSED, ONE A SHORT DISTANCE ABOVE THE OTHER; THE FIRST IS IMMEDIATELY ABOVE THE STITCH AFFIXING THE PERITONEUM AT THE LOWER ANGLE, AND THE UPPERMOST IS JUST BELOW THE LEVEL OF INSERTION OF THE ROUND LIGAMENTS. EACH STITCH PASSES THROUGH THE EDGE OF THE RECTUS SHEATH, IS CARRIED MEDIANLY TO THE CUT EDGE OF THE PERITONEUM THROUGH THE ANTERIOR WALL OF THE UTERUS, PASSES MEDIANLY TO THE EDGE OF THE PERITONEUM AND THROUGH THE RECTUS SHEATH ON THE OPPOSITE SIDE.

Procedure. Other operations such as salpingectomy or myomectomy being completed, the uterus is lifted upwards and forwards by the left hand until the lower uterine segment is brought into the lower angle of the abdominal wound.

The first stitch picks up the parietal peritoneum at the lower angle of the abdominal incision, together with a bite of the front of the uterus at the loose reflection of the peritoneum (fig. 1422).

After being tied, the ends of this stitch may be left long and used as a tractor to hold the uterus upwards and forwards.

Three interrupted stitches are used for this ventro-fixation. The first stitch is passed through the margin of the right rectus sheath, about $\frac{1}{2}$ inch from its cut edge, and is carried medially over the inner border of the rectus muscle and the cut edge of the peritoneum. It is then passed through the anterior wall of the uterus just above the insertion of the tractor suture, the points of entrance and emergence of the needle being about 1 inch apart.

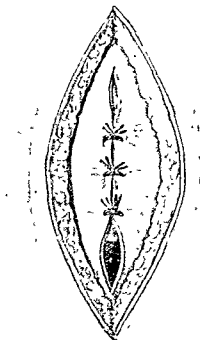


Fig. 1424.—VENTRO FIXATION OF THE UTERUS.
THE THREE FIXATION STITCHES HAVE BEEN TIED.

The needle is then picked up and made to transfix the left rectus sheath, again $\frac{1}{2}$ inch from its cut edge, avoiding the peritoneum and muscle on this side. The ends of the suture are clipped with hæmostats, and a second stitch is introduced in a similar manner, about $\frac{1}{2}$ inch above the previous one. The third stitch is then introduced in the same manner, care being taken to include a bite of the uterus just below the attachments of the round ligaments (*fig. 1423*).

The long ends of the second and third sutures are again clipped with hæmostats. The peritoneum is picked up on each side and sutured from above downwards, the suturing being continued to the level of

the upper stitch where the front of the uterus is secured by the last turn of the peritoneal suture.

The edges of the rectus sheath are then sutured in the usual manner, after which each suspension stitch is firmly tied (fig. 1424) and the skin margins are approximated with interrupted sutures and Michel clips.

Considerable difference of opinion prevails as regards suture material for this fixation. Many surgeons prefer silk or silkworm-gut, maintaining that catgut dissolves so quickly that the attachment stretches and a thin attenuated cord is ultimately formed. This has not been altogether my experience. In some cases the uterus has a considerable amount of movement which might be regarded as advantageous. Thread or silk very frequently causes serum to collect in the wound, or produces a low-grade suppuration with the result that a sinus forms and persists until all the stitches are removed. Silkworm-gut effects a firm and strong attachment of the uterus and is the least likely to cause suppuration or the accumulation of serum. Its use is definitely indicated when there is a considerable backward drag of the uterus.

ABDOMINAL OPERATION FOR INVERSION OF THE UTERUS

The abdominal route may be employed for the treatment of acute or chronic inversion of the uterus.

Acute Puerperal Inversion of the Uterus. When this condition is discovered at the time of its occurrence—usually during delivery of the placenta—shock will be pronounced and no attempt at reposition should be made. The vagina should be packed to arrest hæmorrhage, and the patient treated for shock. Pain should be relieved by injections of morphia.

Johnson's Method

Procedure. A
 1. invert
 at

abdominal incision is made. The
 tified and grasped on each side with
 e rim, and steady upward traction
 yrus out of the crater.
 further down, and the
 is restored to its

normal position. The uterus is then firmly squeezed with a towel wrung out in hot saline to promote contraction.

After-Treatment. Pituitrin $\frac{1}{2}$ cc. is given 4-hourly for 4 doses. Shock is treated by intravenous infusions of gum saline or by blood-transfusion.

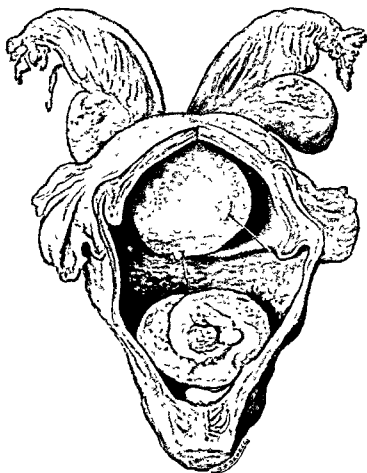


Fig. 1425—CHRONIC INVERSION OF THE UTERUS DUE TO A FIBROID. THE DILATED CERVIX AND LOWER UTERINE SEGMENT HAVE BEEN SPLIT OPEN ANTERIORLY, SHOWING THE INVERTED FUNDUS. THE TUBES AND OVARIO-UTERINE LIGAMENTS CAN BE SEEN DISAPPEARING BEHIND THE ANTERIOR EDGE OF THE CRATER. THE DETACHED FIBROID WHICH CAUSED THE INVERSION IS SEEN LYING IN THE LOWER PART OF THE VAGINA. (Moss, R.C.S.)

Chronic Inversion of the Uterus (fig. 1425). This is an extremely rare condition. When it is not produced by a fibroid, reposition by an Aveling reposer is almost invariably successful, provided that the cup is made so as to fit the inverted portion of the uterus.

Haultain's Operation

The following are the advantages claimed for abdominal over vaginal operations for the cure of chronic inversion of the uterus :

- (a) Hæmorrhage can be more effectively controlled.
- (b) The uterine wall can be sutured more accurately.
- (c) The incision into the uterus is much smaller than in the vaginal operation.

Procedure. The crater with the tubes and round and ovario-uterine ligaments dipping into it is identified ; the anterior edge of the uterus is pulled upwards with a vulsellum, and an incision is made through its posterior edge, dividing the entire thickness of the inverted wall. Two pairs of Allis forceps are applied to the wall of the uterus on each side and steady upward traction is made. The opening in the posterior edge is increased until sufficient relaxation is obtained for the inverted portion to be pulled up to its normal position. The fibroid is then removed.

When this has been done, the uterus is firmly squeezed to promote contraction, and the opening is sutured by interrupted mattress stitches of catgut. The peritoneal edges are then joined by a continuous suture of catgut on an intestinal needle.

After-Treatment. Uterine contractions are stimulated by injections of pituitrin, $\frac{1}{2}$ cc. 4-hourly for 4 doses.

SALPINGECTOMY

This is the operation for removal of the Fallopian tube.

Indications. Hydrosalpinx, pyosalpinx (the ovary being conserved if it is reasonably healthy), or tubal pregnancy.

Contra-indications. Malignant growth of the ovary, uterus or Fallopian tube. In such cases all these structures must be removed. In young patients where there is only a moderate degree of hydrosalpinx, the tubes should be opened up by the operation of salpingostomy and conserved.

Removal of the tube may be partial or complete.

PARTIAL SALPINGECTOMY

The distended tube is picked up and adhesions to surrounding structures are divided, as described under "Salpingo-oöphorectomy." When freed it is lifted up and a pair of artery forceps are placed on the

mesosalpinx between the ovary and tube. A second pair of artery forceps is applied over the top of the broad ligament, seizing the tube and ovarian vessels about $\frac{1}{2}$ inch away from the uterus (fig. 1426).

The tube is now removed by cutting the mesosalpinx beyond the forceps, and the uterine vessels are secured by passing a catgut ligature through the broad ligament about $\frac{1}{2}$ inch from the uterus. This ligature, when tied, also includes the stump of the tube near the cornu.

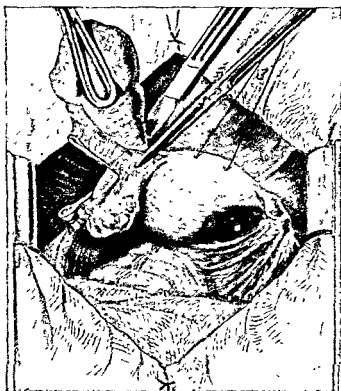


Fig. 1426.—PARTIAL SALPINGECTOMY. THE LEFT TUBE WITH INFOLDED FINGERLE HAS BEEN FREED FROM ADHESIONS. THE MESOSALPINX IS TIED AT ITS LATERAL EDGE AND DIVIDED. THE PROXIMAL END OF THE FALLOPIAN TUBE IS CLAMPED.

The cut edge of the mesosalpinx is secured by two or three mattress stitches (fig. 1427). Only the branches of the ovarian artery which are distributed to the tube are tied; in this way the blood supply to the ovary is not interrupted.

When necessary the tube on the opposite side should be removed in the same manner.

If there are adhesions around the ovaries or back of the uterus, ventro-fixation should be performed and the ovaries suspended to prevent them from prolapsing and becoming adherent in the pouch of Douglas.

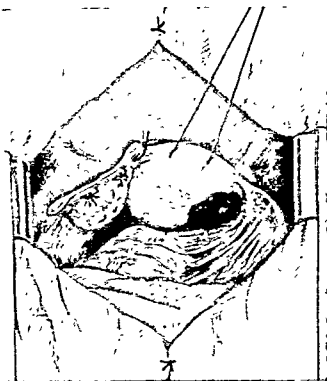


Fig. 1427.—PARTIAL SALPINGECTOMY. THE MESOSALPINX IS SUTURED WITH MATTRESS STITCHES IN THE CENTRAL PART, WHILE AT ITS MEDIAL EDGE THE STITCH ALSO SURROUNDS THE REMNANT OF THE FALLOPIAN TUBE.



Fig. 1428.—COMPLETE SALPINGECTOMY. THE MESOSALPINX IS LIGATED AT ITS OUTER END AND DIVIDED THROUGHOUT ITS LENGTH. THE INTERSTITIAL PORTION OF THE FALLOPIAN TUBE IS INCLUDED IN A WEDGE REMOVED FROM THE UTERINE CORNU.

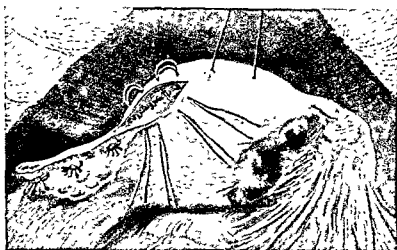


Fig. 1429.—COMPLETE SALPINGECTOMY. BLANKET STITCHES ARE INSERTED THROUGH THE MESOSALPINX AND THROUGH THE UTERINE CORNU.

Drainage is not required unless there is acute inflammation or a likelihood of subsequent oozing of blood or effusion of serum.

COMPLETE SALPINGECTOMY

Indications. This operation is performed for tuberculous salpingitis, pyosalpinx, or occasionally for the sterilisation of the patient.

Contra-indications are the same as for the partial operation.

Procedure. The tube is freed from adhesions and lifted up so that the mesosalpinx can be clamped from without inwards and divided.

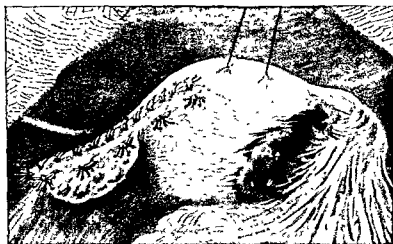


Fig. 1430.—COMPLETE SALPINGECTOMY. THE CUT EDGE OF THE MESOSALPINX AND THE APPROXIMATED EDGES OF THE OPENING IN THE UTERINE CORNU ARE OVERSEWN WITH A CONTINUOUS CATGUT STITCH.

By placing the clamp close to the tube only branches of the ovarian vessels are cut. No clamp is applied at the inner end, but a wedge including the interstitial portion of the tube is removed from the uterine cornu (fig. 1428).

The wound in the uterus bleeds freely. The raw edges are approximated with two or three mattress stitches, the mesosalpinx is secured with stitches (fig. 1429), and a continuous suture oversews the edge of the mesosalpinx and approximates the peritoneal edges of the uterine incision (fig. 1430).

SALPINGOSTOMY

Salpingostomy is the operation for establishing an artificial opening in the Fallopian tube.

Indications. The operation is performed for the cure of sterility due to sealing of the ostium abdominale.

Contra-indication. Closure of the uterine end of the tube.

Pre-operative Investigation. The patency of the tube is investigated either by intra-uterine injections of lipiodol followed by radiography, or by trans-uterine insufflation with CO₂. The former method shows the extent to which the radio-opaque fluid percolates along the tube and reveals the presence and site of obstruction if present. On the other hand, the latter method discloses the presence of obstruction but not its situation; it has the advantage, however, of being more simple.

Procedure. The tube is picked up and freed from any surrounding adhesions. It is then grasped at its free end with a pair of Allis forceps, whilst another pair seizes the free border about 1½ inches internal to the first. Two other pairs are then applied on each side of the tube about half way between the first two pairs. An incision is now made between the two latter pairs, so as to open up the lumen of the tube (fig. 1431). The lateral forceps are retracted and a new ostium is made by extending the incision from the free end of the tube medially for about 1½ inches. The incision must be in the distended part of the tube and must not encroach on the isthmus.

The contents of the tube, whether serous fluid or blood clot, are now evacuated.

The mucous membrane of the tube is next sewn to the peritoneal surface by a series of mattress stitches (fig. 1432). These at the same time arrest hæmorrhage, which is always free.

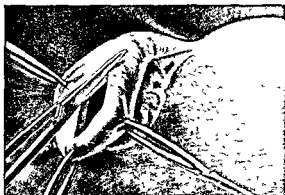


Fig. 1431.—SALPINGOSTOMY. THE LATERAL EXTREMITY AND SIDES OF THE TUBE ARE STEADIED WITH FORCEPS AS THE CAVITY IS OPENED BY A FREE INCISION ALONG ITS ANTI-MESENERGIC BORDER.

All bleeding points must be carefully secured, for if a hæmatoma forms, the tube is liable to become occluded again.

Two mattress stitches are now passed so as to suspend the ovary ;

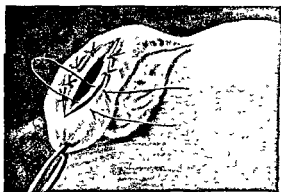


Fig. 1432.—SALPINGOSTOMY. THE TUBAL SEROSA AND MUCOSA ARE UNITED WITH INTERRUPTED AND BLANKET STITCHES WHICH ALSO ARREST HÆMORRHAGE.

the first stitch traverses the round ligament, the mesosalpinx and the ovario-uterine ligament in two places, and is tied ; the second, more lateral, passes through the round ligament and mesosalpinx, takes a bite of the ovary near its lower and outer pole, then passes back through the mesosalpinx and round ligament and is tied. In this way

By placing the clamp close to the tube only branches of the ovarian vessels are cut. No clamp is applied at the inner end, but a wedge including the interstitial portion of the tube is removed from the uterine cornu (fig. 1428).

The wound in the uterus bleeds freely. The raw edges are approximated with two or three mattress stitches, the mesosalpinx is secured with stitches (fig. 1429), and a continuous suture oversews the edge of the mesosalpinx and approximates the peritoneal edges of the uterine incision (fig. 1430).

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Procedure. The tube is picked up and freed from any surrounding adhesions. It is then grasped at its free end with a pair of Allis forceps, whilst another pair seizes the free border about $1\frac{1}{2}$ inches internal to the first. Two other pairs are then applied on each side of the tube about half way between the first two pairs. An incision is now made between the two latter pairs, so as to open up the lumen of the tube (fig. 1431). The lateral forceps are retracted and a new ostium is made by extending the incision from the free end of the tube medially for about $1\frac{1}{2}$ inches. The incision must be in the distended part of the tube and must not encroach on the isthmus.

The contents of the tube, whether serous fluid or blood clot, are now evacuated.

The mucous membrane of the tube is next sewn to the peritoneal surface by a series of mattress stitches (fig. 1432). These at the same time arrest hæmorrhage, which is always free.

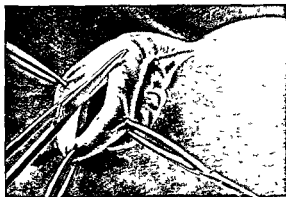


Fig. 1431.—SALPINGOSTOMY. THE LATERAL EXTREMITY AND SIDES OF THE TUBE ARE STEADIED WITH FORCEPS AS THE CAVITY IS OPENED BY A FREE INCISION ALONG ITS ANTI-MESENTERIC BORDER.

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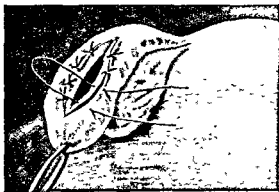


Fig. 1432.—SALPINGOSTOMY. THE TUBAL SEROSA AND MUCOSA ARE UNITED WITH INTERRUPTED AND BLANKET STITCHES WHICH ALSO ARREST HÆMORRHAGE.

the first stitch traverses the round ligament, the mesosalpinx and the ovario-uterine ligament in two places, and is tied ; the second, more lateral, passes through the round ligament and mesosalpinx, takes a bite of the ovary near its lower and outer pole, then passes back through the mesosalpinx and round ligament and is tied. In this way

the ovary is suspended, and the new ostium of the tube lies closely in contact with its inferior aspect.

The same procedure is carried out on the opposite side if required.

Difficulties. The chief difficulty is in arresting hæmorrhage, first from divided adhesions which previously bound the tube, and secondly from the cut edges of the tubal ostium.

TUBAL RESECTION WITH IMPLANTATION OF THE STUMP OF THE TUBE INTO THE UTERUS

This is an operation whereby an obstructed part of the tube is resected and the medial end of the remaining part of the tube is implanted direct into the uterine cavity.

Procedure. The abdomen having been opened and the operation area packed off, the uterus is lifted up and grasped with a Bonney myomectomy clamp around the cervico-corporeal junction, the ovarian vessels being controlled with the intestinal clamps. In this way the uterus is steadied and all circulation is temporarily arrested.

The extent of tubal patency is determined by passing a fine probe along the lumen until it meets the obstruction. The tube and its mesentery are now divided distal to the occlusion. The proximal end of the patent outer portion of the tube is split for $\frac{1}{4}$ inch, forming anterior and posterior lips, each of which is caught with a blanket stitch.

The part of the tube which is attached to the uterus, together with the interstitial portion, is excised and the cornu of the uterus is opened up, exposing the uterine cavity.

Three or four strands of silkworm-gut are tied together to form one large knot, leaving the ends about $1\frac{1}{2}$ inches in length. These free ends are then inserted into the lumen of the tube between the new-formed lips, the knot being left to lie free so that it may be passed into the uterus. The ends of the two blanket stitches are now threaded on needles, and are passed into the cavity of the uterus. The anterior suture pierces the anterior wall, while the two ends on the posterior lip are passed out through the posterior wall. Traction is made on these ends, and at the same time the two lips containing the strands of silkworm-gut are thrust with a pair of forceps into the uterine cavity

through the new-made opening in the cornu, the knot lying free inside the uterus.

The two blanket stitches are now drawn tight and tied, and the opening in the uterus is closed with interrupted stitches, care being taken not to exert pressure on the newly inserted tube. The peritoneum at the edge of the cornual opening is stitched around the tube and on the medial side of the tubal insertion, the edges being oversewn with fine catgut. All bleeding is carefully arrested.

After-Treatment. A week later the silkworm-gut is removed by inserting the long uterine forceps through the cervix. Inflation of the tubes is carried out at the same time with CO₂ at moderate pressure not above 100 mm. Hg., and this is repeated on three subsequent occasions at weekly intervals.

ALTERNATIVE TECHNIQUE

The steps of the alternative operation are the same until the occluded part of the tube has been removed, except that the inner end of the tube is not split. Layers of the uterine cornu are then shaved off with a scalpel until the uterine cavity is opened.

The uterus is split antero-posteriorly for a depth of about 1½ inches, thus opening its main cavity; each edge of the uterus is then retracted laterally.

A long straight needle is inserted, eye first, along the Fallopian tube from the ostium abdominale through the cornual opening into the uterus, and is brought out through the new-made opening. Here it is threaded with a double strand of catgut, the uterine end of which is tied in a very large knot, the free end being pulled through the tube and left to hang loose at the fimbriated end.

The incision in the uterine fundus is closed with mattress sutures of catgut, and the peritoneal edges are united by a continuous stitch of catgut on an intestinal needle.

The mesial end of the tube is now brought up against the uterine cornu, the catgut which traverses the lumen keeping the openings in the tube and cornu in correct alignment. A few interrupted catgut stitches attach the tube to the cornu. All bleeding points are carefully secured, and the abdomen is closed in the usual manner.

After-treatment is similar to that of the first method.

being conserved if possible (fig. 1435). It is seldom, however, that these cases are diagnosed before rupture has occurred.

At the time of acute rupture or tubal abortion with effusion of blood into the peritoneum. Operation must be undertaken at once and performed with expedition. After the abdomen has been opened the uterus should be picked up immediately by hand and the gravid tube identified, swiftly freed and lifted up out of the pelvis (fig. 1436);

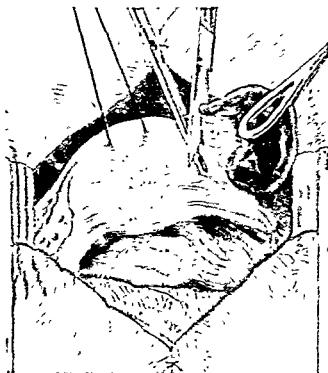


Fig. 1435.—EXTRA-UTERINE PREGNANCY. THE AFFECTED TUBE FROM WHICH THE OVARY IS INSEPARABLE IS LIFTED UPWARDS. THE OVARIO-FALLOPIAN LIGAMENT IS EXPOSED AND TIED, AND THE BROAD LIGAMENT IS CLAMPED NEAR THE UTERUS. THE AFFECTED TUBE AND OVARY ARE THEN REMOVED BY THE OPERATION OF SALPINGO-OOPHORECTOMY.

pulling the tube upwards will temporarily arrest further bleeding. Salpingectomy is then performed. When the ovary is involved in adhesions, is cystic, or too much time would be lost in trying to preserve it, salpingo-oophorectomy is the better operation (fig. 1437). The opposite tube, if not diseased they are conserved. Clotted blood and if not diseased they are hard and liquid blood is mopped up from the pelvis. The patient is very collapsed. Blood, nor the condition of shock be increased, which would be

entailed in the process. During the operation an intravenous saline injection may be given if shock and anæmia are pronounced.

For Ruptured Interstitial Gestation. Operation should be performed as early as possible in such cases, as bleeding is always free and continuous. Where the uterus is extensively lacerated, sub-total hysterectomy is indicated as hæmorrhage can thereby be more quickly and completely controlled. If the condition of the patient permits, an

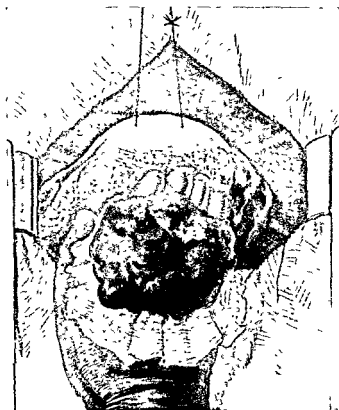


Fig. 1438.—EXTRA-UTERINE PREGNANCY. THE AFFECTED TUBE HAVING BEEN FREED AND LIFTED UPWARDS, BLOOD CLOT IS REMOVED WITH THE FINGERS COVERED BY A GAUZE SWAB.

attempt should be made to conserve the uterus. A Bonney myomec-tomy clamp is applied to the supra-vaginal cervix and ring forceps are placed on the ovario-pelvic ligaments to arrest further bleeding. The ragged lacerated cornu of the uterus is removed, together with the tube and ovary, the aperture in the uterus is obliterated with mattress stitches of catgut, and the edges of the peritoneum are united by a continuous suture of the same material. An intravenous saline infusion will be required in most cases during the operation, followed later by a blood-transfusion.

After tubal rupture or abortion when there is a pelvic hæmatocele. Omentum and infrequently coils of bowel will be found adherent to the back of the uterus and its appendages, especially on the affected side. Adhesions are separated, blood clot is removed, and the lacerated tube is isolated and removed by salpingectomy or salpingo-oöphorectomy. Drainage will be necessary when there is any evidence of infection of the hæmatocele.

When there is tubal rupture with a broad ligament hæmatoma. Occasionally the hæmatoma is small and limited to the upper part of the broad ligament, when it may be removed together with the affected tube. If, however, the effusion occupies the whole of the broad ligament or extends widely behind the peritoneum, the tube and ovary should be excised after securing the vessels in the ovario-pelvic ligament laterally and in the upper part of the broad ligament medially. As much as possible of the clot is then removed. If oozing persists, the cavity should be packed with a roll of gauze, the end of which is brought out through a large rubber drainage-tube. The pack and tube are removed after 36 hours.

On rare occasions when hæmorrhage is free and uncontrollable, hysterectomy may be required.

When there is secondary abdominal or intra-ligamentous pregnancy. These cases are very rare. The embryo, having survived tubal rupture or abortion, continues to grow either in the peritoneal cavity or between the layers of the broad ligament, and the placenta as it develops forms further attachments to surrounding structures.

The chief difficulty encountered is the control of the vessels supplying the placenta, and these should first be inspected before any attempt is made to remove the gestation sac. When this sac lies within the peritoneal cavity, the placenta will probably be attached to the uterus or broad ligament and usually to the omentum also. In such cases the omentum and the ovarian and uterine vessels are first secured, and the gestation sac is removed after opening it and delivering the foetus. It may even be necessary to perform sub-total hysterectomy in order to control hæmorrhage.

When the gestation sac lies between the layers of the broad ligament (extra-peritoneally) it is more difficult to secure the vessels supplying the placenta, and these may need to be cut in order to remove the foetus. Bleeding, which will then be free, should be arrested with blanket stitches if possible. Occasionally the sac may be opened

and the foetus removed without interfering with the placenta. In either case it will be safer not to remove the sac which may either be *marsupialised*—its edges being sewn to the opening in the parietal peritoneum and its cavity drained, or *sequestered*, by sewing it up and leaving it *in situ*.

The majority of surgeons are in agreement with the procedure just described for cases where pregnancy has not advanced beyond the fifth month. It is the view of many that after this date hæmostasis will be difficult following removal of the placenta owing to its increased size, its vascularity, and the extent of its attachments. It is therefore considered safer to wait until term, when there will be a "false labour," the uterine decidua will be passed, and the foetus will die. Operation is then postponed for another month, when maternal circulation in the placenta will have ceased and the foetus may be safely removed together with the placenta.

The chief disadvantage of waiting is that the gestation sac may become infected, or secondary rupture may occur with severe hæmorrhage, in either case causing the death of the patient.

OVARIAN SUSPENSION

This operation entails shortening the ovario-uterine ligament.

Indications. The ligament sometimes becomes elongated, and as a result the ovary lies in the pouch of Douglas and may cause dyspareunia despite the fact that the fundus uteri is forward in the normal position. In this case the ligament may with advantage be shortened. The ovary should also be suspended when there is risk of its becoming adherent to the raw surface left after salpingectomy.

Procedure. The uterus is lifted up and pulled forwards to allow the ovary to be examined. The ovario-uterine ligament is pleated by passing a stitch of catgut backwards and forwards through it three or four times, beginning at its junction with the uterus and ending near the ovary. The two ends of the double stitch are then tied, throwing the ligament into a series of folds which shorten it and fix the ovary close to the uterus.

may be adherent in the pelvis. The fundus of the uterus is identified by the round ligaments which approach it from the inguinal region. The position of the bladder is noted, and the omentum recognised by its characteristic appearance. Coils of small intestine may appear to be continuous with the posterior surface of the uterus and the swollen tubes.

The omentum is then picked up and peeled off the uterus and swollen appendages (fig. 1439); if torn, it will bleed and must be ligated



Fig. 1439.—SALPINGO-OOPHORECTOMY. THE ADHERENT RIGHT TUBE AND OVARY ARE BEING STRIPPED FREE WITH THE FINGERS.

with catgut. Bowel is separated by finding the plane of adhesion and following it with the fingers. Undue force or pulling on the intestine must be avoided.

The part of the Fallopian tube which enters the uterus is rarely much enlarged and can usually be easily recognised. By following it downwards and backwards, the position and general outline of the swollen portion of the tube can be identified. Separation should begin in the mid-line posteriorly and be carried outwards. The fingers should be worked deep to and around the tubes, after which gentle to-and-fro manipulation will free them from the depths of the pelvis. Dense adhesions may be divided with scissors.

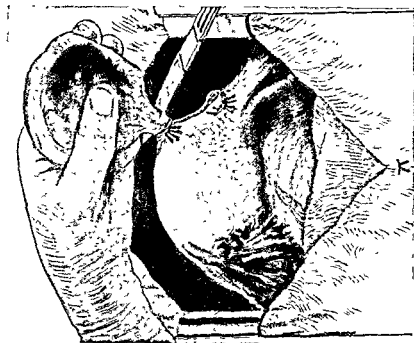


Fig. 1441.—SALPINGO-OOPHORECTOMY. THE UPPER PART OF THE BROAD LIGAMENT NEAR THE UTERUS IS TRANSFIXED AND TIED, SECURING THE VESSELS IN THIS SITUATION. THE DISEASED APPENDAGES ARE THEN REMOVED BY DIVIDING THE REMNANT OF THE BROAD LIGAMENT AND THE FALLOPIAN TUBE NEAR THE UTERUS.

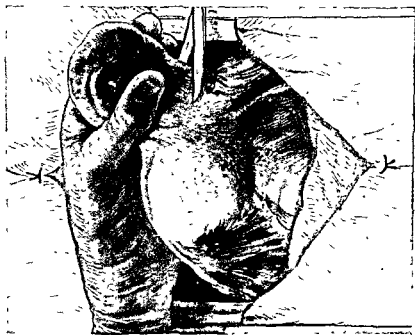


Fig. 1440.—SALPINGO-OOPHORECTOMY. THE LEFT APPENDAGES ARE PULLED UPWARDS AND THE BROAD LIGAMENT DIVIDED AFTER UNDER-RUNNING AND TYING THE OVARIAN VESSELS IN THE OVARIAN PELVIC LIGAMENT.

The vessels supplying the diseased structures are now secured by underrunning and tying with catgut, first the ovario-pelvic ligament (fig. 1440), and then the upper part of the broad ligament $\frac{1}{2}$ inch lateral to the uterus (fig. 1441). The ovario-pelvic and broad ligaments are then divided $\frac{1}{2}$ inch distal to each ligature and cut across deep to the swollen structures, thus freeing them and permitting of their removal. The tube and ovary on the opposite side are excised in the same way.

The peritoneum of the broad ligament and pelvic wall is usually too indurated and friable to permit of covering the pedicles or oversewing the cut edges.

Ventro-fixation should be performed to prevent the uterus from falling backwards and becoming adherent.

When there is extensive oozing from blood-vessels in the divided adhesions, the pelvis should be drained for 48 hours. When pus has been present, particularly if the condition is recent or follows puerperal or post-abortum sepsis, drainage is also necessary. Pus in distended tubes or ovaries is often sterile, and although this may escape during operation, soiling the surrounding tissues, there is little risk of further acute inflammation.

Plastic lymph in varying stages of organisation and wide raw areas are frequently left after this operation. There is, however, little tendency for the bowel to become adherent, as it seems probable that when the septic structures are removed resolution takes place with complete absorption of exuded lymph. Subsequent abdominal exploration usually reveals few or no adhesions of intestine, and on vaginal examination softness, suppleness and lack of tenderness are found.

Dangers. Accidents that may happen during division of adhesions :

(1) *Escape of pus* is a common accident, frequently unavoidable, especially when there is also an abscess of the ovary, the tissues of which are extremely friable. It is not, however, usually attended by widespread infection except in acute cases following post-partum or post-abortum sepsis. When the condition is one of long standing, pus is generally sterile, organisms failing to grow on culture media. An active infection must be suspected when the diseased tissues are very red and congested and are covered with plastic lymph ; if, however, the tissues are pale it is evidence that the infection is not highly virulent. The accident can frequently be prevented by finding the plane of separation and following it closely, and by avoiding too strenuous manipulations or pulling on the friable structures.

Wide contamination by the liberated pus is prevented by carefully packing off the operation area and by quickly and thoroughly mopping up the pus as it escapes.

In all these cases the pelvis should be drained after operation.

(2) *Laceration of the Bowel.* The small bowel, rectum or sigmoid colon may be wounded during the division of adhesions. The most common injury is rupture of the peritoneal and muscular coats of the gut; occasionally the lumen of the gut may be opened. This must be prevented by finding the plane of cleavage and carefully separating adhesions and by avoiding undue traction on the intestines or inflamed appendages. When firm fibrous adhesions are cut, the point of the scissors must be directed away from the bowel and the fibrous union divided at the expense of the adherent structure. Laceration of intestine if not repaired may result in peritonitis or faecal fistula.

A careful examination must be made of every loop or portion of bowel separated, to ascertain whether there has been a rent and, if so, its extent. When only the peritoneal and muscular coats are torn, the injury must be repaired with interrupted Lambert sutures. The bowel may sometimes be so friable as the result of inflammatory induration that stitching is impossible. In such cases it is better to desist from further efforts at suture, and to be content with protecting the raw surface with omentum. When the lumen is opened, the hole must be closed by a two- or three-tier suture.

After wounding the bowel, drainage of the pelvic cavity is necessary, especially if there has been soiling of the tissues with bowel contents. A faecal fistula may occur after drainage, but even so a faecal fistula is less serious than peritonitis should the suture line give way.

(3) *Laceration of Blood-vessels.* Tearing of vessels in the omentum, mesosigmoid or rectum is a very common accident. Injury to larger vessels such as external or internal iliac veins is of rare occurrence. When separating adhesions in their neighbourhood it is better to divide the attachment, leaving a small piece of the tube or ovary behind. Should the vein be torn, bleeding must be temporarily arrested by pressure, after which the opening should be clipped with forceps and tied.

(4) *Injury to the Ureter.* The ureter may be punctured with a needle or included in a ligature at the brim of the pelvis when securing an indurated and contracted ovario-pelvic ligament, or at the base of the broad ligament when a rent in this situation is being sutured. The ureter must be identified before any ligatures are tied in its neighbourhood.

(5) *Fenestration of the Broad Ligament.* When separating the swollen appendages from the posterior aspect of the broad ligament, a hole may be made through which bowel may protrude and become strangulated. Such a rent must be closed with catgut stitches, care being taken to ascertain the exact position of the ureter.

(6) *Post-operative Oozing of Blood.* New-formed blood-vessels in the adhesions are troublesome during separation of the appendages and oozing may be free. When bleeding cannot be controlled, drainage should be provided for 48 hours lest a pelvic hæmatoma should form.

OPERATION FOR PSEUDO-BROAD LIGAMENT CYST

This cyst is of ovarian origin. It does not lie within the layers of the broad ligament but is invaginated into its posterior aspect. The broad ligament thus envelops most of the cyst, and the free border

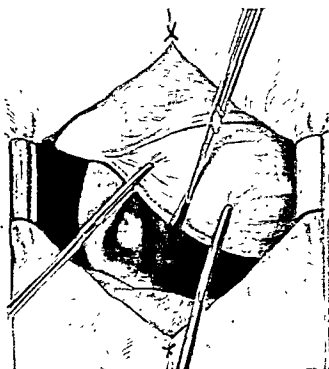


Fig. 1442.—OPERATION FOR PSEUDO-BROAD LIGAMENT CYST. THE UPPER BORDER OF THE BROAD LIGAMENT IS FREED FROM THE CYST AND CLAMPED NEAR ITS CENTRE AND NEAR THE UTERUS; IT IS THEN DIVIDED DOWN TO THE LEVEL OF THE OVARIAN ATTACHMENT.



Fig. 1443.—OPERATION FOR PSEUDO-BROAD LIGAMENT CYST. THE CYST IS NOW STRIPPED FROM THE BACK OF THE BROAD LIGAMENT AND LIFTED OUT OF THE PELVIS.

containing the Fallopian tube and ovarian vessels appears to lie behind the cyst.

Procedure. A hand is passed deep into the pelvis and an attempt is made to free the tumour on its mesial and inferior aspects. The ovario-pelvic ligament is transfixed and tied, the ovarian vessels near the uterus are secured in the same manner, and the broad pedicle of



Fig. 1444.—OPERATION FOR PSEUDO-BROAD LIGAMENT CYST. A LIGATURE IS PASSED THROUGH EACH DIVIDED HALF OF THE BROAD LIGAMENT SO AS TO UNDERRUN THE VESSELS, THE TWO STITCHES INTERLOCKING.

the tumour divided. The cyst is then removed, after which the cut edges of the peritoneum are brought together with a continuous catgut stitch.

When adhesions are too dense for the tumour to be freed, a different procedure is necessary.

The free edge of the broad ligament is identified by the position of the Fallopian tube, separated from the upper aspect of the cyst, and clamped with two pairs of artery forceps which include the Fallopian tube, the broad ligament and the ovarian vessels (fig. 1442). These forceps are placed so that one pair is near the uterus and the other pair

is near the centre of the broad ligament. The broad ligament is then divided between them as far as the attachment of the ovary, and the tumour is stripped from its attachments and lifted upwards (fig. 1443).

Each half of the divided broad ligament is now transfixed with a ligature which also includes the ovarian vessels (figs. 1444 and 1445).

Difficulties are principally those of separating the tumour from surrounding structures such as the bowel or the peritoneum of the pelvic floor.



Fig. 1445.—OPERATION FOR PSEUDO-BROAD LIGAMENT CYST. THE INTERLOCKING STITCHES WHEN TIED PULL THE TWO HALVES OF THE BROAD LIGAMENT TOGETHER.

Dangers are those of injury to the bowel, large blood-vessels or ureters. Bowel may be attached closely to the cyst, being spread out over its surface. When adhesions deep in the pelvis are being divided, some of the large veins are liable to be injured and resultant bleeding is difficult to control. The ureter may be cut or included in a ligature; this is avoided by continually verifying its position during separation of the tumour and ligation of the broad ligament.

In the case of a pseudo-broad ligament cyst, the ureter always lies on the outer side, while with a true broad ligament cyst it is on the inner aspect.

OPERATION FOR BROAD LIGAMENT FIBROMYOMATA

Fibroids may grow from smooth muscle at the side of the uterus or from the para-cervical tissue, the round ligament or the ovario-uterine ligament.

In the two latter positions the tumours are usually small and can be enucleated without much difficulty. When growing from para-cervical tissue the tumour may attain a large size, expanding the broad ligament, and stripping up the peritoneum from the lateral and posterior pelvic walls. When growing on the left side of the pelvis, it may open the mesosigmoid, so that bowel lies directly over its surface.

These growths are not attached to the uterus which, however, may be considerably displaced though not deformed. They always lie lateral to the uterine artery and above and to the outer side of the ureter.

When the myoma is small it may be shelled out of its bed with the fingers after clamping and dividing the broad ligament. If very large or vascular, hysterectomy may be necessary in order to control hæmorrhage, and in this case the procedure will be the same as that described for lateral cervical myoma.

OPERATIONS FOR TRUE BROAD LIGAMENT CYSTS

True broad ligament cysts (with the exception of those growing from the outer part of the mesosalpinx) have no pedicle. They are found principally in three situations :

- (1) In the mesosalpinx, growing above the ovarian vessels, which are pushed downwards and lie on its *déep* surface.
- (2) In the broad ligament lateral to the uterine artery and deep to the ovarian vessels. These cysts when large may strip up the peritoneum, obliterate the pouch of Douglas, and form adhesions to the back of the uterus and the opposite broad ligament; they may even extend into the mesosigmoid, or lift up the peritoneum and rectum, coming to lie behind the bowel. The ureter lies on the medial aspect of the cyst.
- (3) Low in the broad ligament below the uterine vessels which are lifted up, and which, together with the ovarian artery and vein, lie along its upper surface. The ureter also is elevated and the cyst may spread far and wide behind the peritoneum.

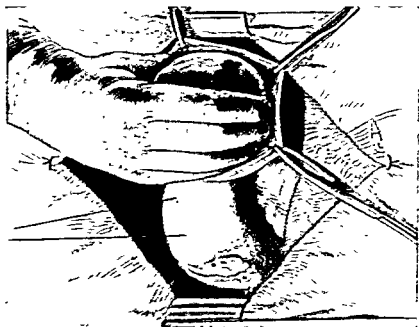


Fig. 1417.—OPERATION FOR TUBER BROAD LIGAMENT CYST. THE CUP END OF THE FOLLICULAR BRIND EXTRACTED, THE CYST IS BRIND EXTRACTED FROM THE BRIND IN THE BROAD LIGAMENT WITH THE HAND.

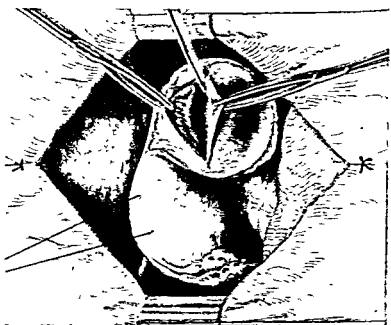


Fig. 1418.—OPERATION FOR TUBER BROAD LIGAMENT CYST. THE FOLLICULAR BRIND EXTRACTED, THE CYST IS BRIND EXTRACTED FROM THE BRIND IN THE BROAD LIGAMENT WITH THE HAND.

Procedure. The limits of the cyst are determined and the structures related to its upper aspect are investigated. In tumours of groups (1) and (2) the ovarian vessels and tube run across the upper aspect, while in group (3) the uterine vessels and *ureter* also may occupy this position.

An area free from blood-vessels is chosen and the peritoneum is incised, care being taken not to cut so deeply as to open the cyst (fig. 1446).

The opening in the peritoneum having been extended, the edges are caught with artery forceps and retracted; the fingers are inserted, and following the line of cleavage the cyst is shelled out of its bed (fig. 1447). Should it be torn during the dissection, the margins of the opening must be clipped with artery forceps to arrest further escape of contents, after which the enucleation can be continued. When the cyst is very large, it may be tapped and partially evacuated.

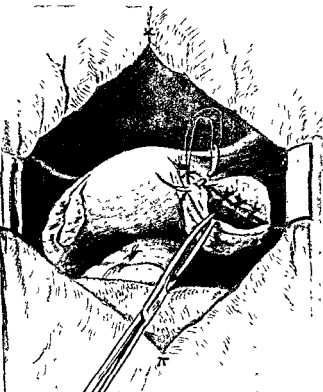


Fig. 1448.—OPERATION FOR TRUE BROAD LIGAMENT CYST. THE SPACE IN THE BROAD LIGAMENT HAVING BEEN OBLITERATED FROM THE BOTTOM UPWARDS WITH CATGUT STITCHES, THE EDGES OF THE PERITONEUM ARE APPROXIMATED AND INFOLDED WITH A CONTINUOUS SUTURE.

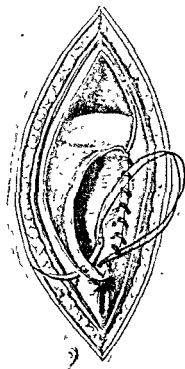


Fig. 1449.—OPERATION FOR TRUE BROAD LIGAMENT CYST. THE EDGES OF THE CYST CAVITY OF THE BROAD LIGAMENT ARE SEWN TO THE CUT EDGES OF THE PARIETAL PERITONEUM WHICH IS AFTERWARDS CLOSED ABOVE AND BELOW THIS SUTURE LINE. THE CAVITY IS THEN PACKED AND DRAINED.

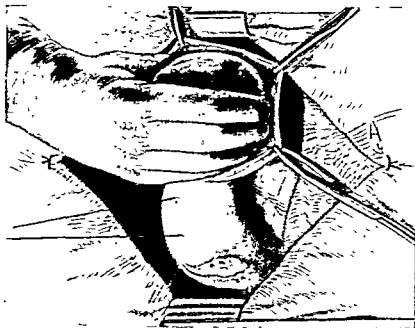


FIG. 1447.—OPERATION FOR TRUE BROAD LIAMENT CYST. THE CUT RINGS OF THE PERITONEUM BEING DETACHED, THE CYST IS MANIPULATED FROM ITS PED IN THE BROAD LIAMENT WITH THE HAND.

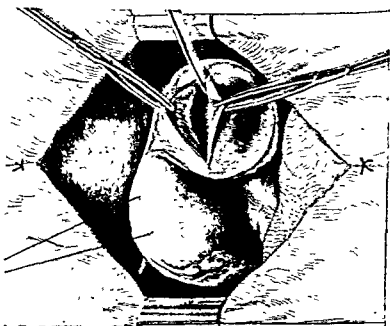


FIG. 1448.—OPERATION FOR TRUE BROAD LIAMENT CYST. THE PERITONEUM OVERLYING THE CYST IS PULLED UPWARDS, AND IS DETACHED AS IT IS LIFTED.

Procedure. The limits of the cyst are determined and the structures related to its upper aspect are investigated. In tumours of groups (1) and (2) the ovarian vessels and tube run across the upper aspect, while in group (3) the uterine vessels and *ureter* also may occupy this position.

An area free from blood-vessels is chosen and the peritoneum is incised, care being taken not to cut so deeply as to open the cyst (fig. 1446).

The opening in the peritoneum having been extended, the edges are caught with artery forceps and retracted; the fingers are inserted, and following the line of cleavage the cyst is shelled out of its bed (fig. 1447). Should it be torn during the dissection, the margins of the opening must be clipped with artery forceps to arrest further escape of contents, after which the enucleation can be continued. When the cyst is very large, it may be tapped and partially evacuated.

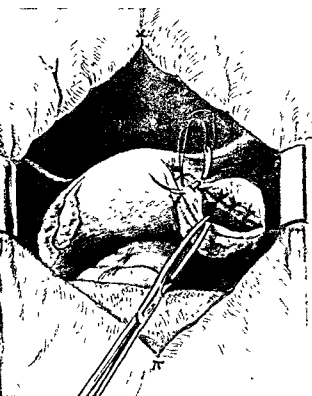


Fig. 1448.—OPERATION FOR TRUE BROAD LIGAMENT CYST. THE INCISION IN THE BROAD LIGAMENT HAVING BEEN OBLITERATED FROM THE BOTTOM UPWARDS WITH CATGUT STITCHES, THE EDGES OF THE PERITONEUM ARE APPROXIMATED AND IS FOLDED WITH A CONTINUOUS SUTURE.

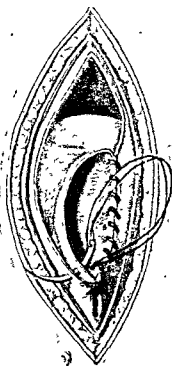


Fig. 1449.—OPERATION FOR TRUE BROAD LIGAMENT CYST. THE EDGES OF THE CYST CAVITY OF THE BROAD LIGAMENT ARE SEWN TO THE CUT EDGES OF THE PARIETAL PERITONEUM WHICH IS AFTERWARDS CLOSED ABOVE AND BELOW THIS SUTURE LINE. THE CAVITY IS THEN PACKED AND DRAINED.

The exact position of the ureter and uterine and ovarian vessels must be determined. The cavity is then obliterated with catgut sutures and any bleeding vessels are caught and tied (fig. 1448).

Alternative Technique. When owing to dense adhesions enucleation is impossible, the cyst may be tapped and emptied; it is then pulled upwards, the ureters and important vessels are defined, and the ovario-pelvic ligament is ligated and cut. The uterine vessels are also under-run and tied, and the intervening broad ligament is excised together with the cyst wall for the greater part of its extent. An attempt is then made to strip the remaining portion of the cyst wall from the cavity. If this proves impossible, a portion of the cyst wall may be left *in situ* and its edges sutured to the opening in the parietal peritoneum (fig. 1449). When the cyst is large, lying under the ureter and perhaps elevating the bowel, enucleation may be extremely difficult and dangerous. In such cases it is safer to choose a bloodless area on the surface, to tap and drain the cyst, remove as much as possible of its wall, sew the edges to the opening in the parietal peritoneum, and pack and drain the cavity.

TUBO-OVARIAN ABSCESS OR CYST

A tubo-ovarian abscess or cyst may form a large swelling which, adhering to the back of the broad ligament, elevates and stretches this structure over its anterior and upper surfaces. The distended Fallopian tube, which forms the edge of the broad ligament, lies over the posterior aspect of the swelling. Frequently the distended ovarian part of the cyst can be isolated by dissection with the fingers, beginning medially and working backwards and outwards. The distended tube and ovary when freed should be removed and the operation completed as in salpingo-oophorectomy.

Occasionally the mass is so adherent to the broad ligament that separation from this structure is not feasible. In such a case the non-distended part of the Fallopian tube near the uterus is identified and clamped. The ovario-pelvic ligament is also clamped, and the intervening portion of the broad ligament, together with the tubo-ovarian cyst, is cut free and removed.

SECTION 3

STERILITY IN WOMEN

by

SIDNEY FORSDIKE

STERILITY is a problem of profound interest not only to the individual but also to the State. To the individual it may be the source of the greatest unhappiness and despair not infrequently ending what would otherwise have been an ideal union. The welfare of a State is dependent upon the fertility of its people. The woman generally accepts the suggestion that she is at fault, and is willing to submit to anything and everything to remove the stigma. The man often declines to listen to the suggestion that it is possible for the responsibility to lie with him, and he frequently refuses to submit himself to examination; his womenfolk foster the idea that the wife is barren, and she ultimately accepts the suggestion and sinks into a state of despair; then wanders from one practitioner to another, being dilated by one, curetted by another, and treated by a third with the much advertised and expensive gonadic hormones of the commercial biologists. We see many of these women squandering their maternal instinct on domestic animals while the man seeks consolation elsewhere. The solution of a problem in sterility should not be lightly abandoned, for it is of fundamental importance to the happiness of the couple concerned.

Sterility appears to bear two meanings; one, a woman who does not bear a living child: so that a woman who becomes pregnant and carries to term but with a dead foetus is regarded as sterile. This definition is misleading, for, whatever other term be used to describe this condition, she is not infertile since she provides conclusive evidence of having been fertilised. The other meaning is that of a woman who offers no evidence of being fertilised. In my view the latter description is the true one, and certainly the most useful from a clinical standpoint, for once an ovum is fertilised, whatever may happen or recurrently

happen, the woman cannot be described as a barren woman. Recurrent abortions which would come under the first definition are, of course, very important and often difficult cases to deal with, but they are not comparable to the difficulty of the problem of infertility in an apparently healthy woman. I am only concerned with the causes of sterility in women, but, in the course of an exhaustive investigation, the part played by the man must be considered in so far as we must ascertain whether he delivers healthy spermatozoa into the vagina of the woman. In those cases where he fails to do this our inquiry ceases when we have established the fact, and the man is referred to a genito-urinary surgeon for investigation and treatment.

Fertility is dependent upon the deposition of healthy spermatozoa in a normal vagina. The cervix and uterus must be in a state favourable for the transmission of the spermatozoa, and the endometrium must be in a suitable condition for the embedding of the ovum. The ovaries must ovulate and function normally, and the Fallopian tubes must offer no obstruction to the passage of healthy ova. A breakdown at any of these points may result in sterility, and they must all be tested methodically in the effort to solve the question. Physiological sterility occurs before puberty at a time when the ovaries are immature, and again after the menopause when they have ceased to function. Temporary physiological sterility occurs during lactation and as a result of debilitating illness. The period of fertility is commonly measured by the length of menstrual life, but exceptions are recorded where women long past the menopause have borne children. Menstruation is not essential to conception, for many women conceive while suckling, even though menstruation has not been re-established since the birth of the child.

Primary Sterility may be divided into two broad classes :

- (1) Absolute.
- (2) Relative.

Absolute sterility means that a woman is incapable of being fertilised owing to complete absence or lack of development of the essential organs of generation, or to their destruction by new growth or operation. Such conditions include absence of vagina, failure in development of the uterus and tubes, and destruction of the ovaries by disease, operation or irradiation.

This class is of little interest from the point of view of treatment, and therefore requires no discussion.

Relative sterility means that a woman, living a normal marital life and who possesses the essential organs of generation, remains sterile. This class can be profitably divided into two groups :

- (1) Cases with an ascertainable lesion which accounts for or contributes to infertility.
- (2) Cases which are normal on physical examination.

Group 1 includes all those cases of minor maldevelopments such as acute flexion, small cervix, stenosis of the vagina with closure by membrane, etc., and the graver lesions associated with infection, and new growths of uterus, tubes or ovaries.

Group 2 is the more interesting group to deal with, for although a majority of these cases are ultimately found to have an associated organic lesion, there is a large minority in which no explanation can be found for the sterility. A certain number of these patients are relieved by inflation of the Fallopian tubes, while a further number are relieved by the injection of lipiodol. A few are instances of relative sterility in both man and wife. In a few cases stimulation of the ovaries or pituitary body by X-rays has been followed by pregnancy, in other cases the soluble products of the endocrine glands improve matters ; but ultimately we come to a small residuum which does not respond to any treatment and they remain sterile.

Secondary or acquired sterility occurs in women who have borne one or more children after which they remain sterile. This condition is usually associated with acquired disease of the uterus, tubes or ovaries.

PHYSIOLOGY OF SEX FUNCTION

Some consideration of physiology is necessary if we are to obtain an intelligent view of the causes of sterility.

Fertility is dependent upon the union of a normal spermatozoon from the male with a healthy ovum from the female, and necessarily means not only the formation of normal spermatozoa in the testicle, but also the ability to transfer them to the vagina ; it further means that the woman must not only produce healthy ova, but that her genital canal should offer unimpeded passage to them. The ovum is formed in the ovary, and the changes which take place in the Graafian follicle incidental to its expulsion comprise ovulation. Ovulation may occur apart from menstruation, e.g. women become pregnant in periods of amenorrhœa ; and menstruation may occur in cases where no

ova are expelled from the follicle, e.g. cases of sterility where the ovaries are enclosed in a thick tunica albuginea. When the ovum is expelled from the Graafian follicle it normally passes through the ostium abdominale into the Fallopian tube where it meets the spermatozoa and conjugation is effected; it then passes down into the uterine cavity where implantation occurs. Implantation of a fertilised ovum therefore depends upon a normal ovary, a patent ostium, normal Fallopian tube, and healthy endometrium. When any of these are abnormal, conception may fail; the ovum may not gain access to the tube, or the abnormal tube may trap the ovum, preventing its progress, and resulting in an extra-uterine gestation or more probably the death of the ovum. All these processes are hidden from view, and although we may be able to determine the patency of the tube, and to a certain extent the condition of it, we have no means of detecting whether the ovary throws off ova save by an abdominal operation. So far as the male is concerned we can say definitely whether he manufactures spermatozoa which approach to the normal, and also whether he is capable of delivering them into the vagina.

To examine seminal fluid microscopically the specimen must be freshly ejaculated and maintained at body temperature; a drop should be placed upon a warm slide covered with a warm cover-slip and the preparation examined under $\frac{1}{2}$ objective. With this magnification the coarse structure of the spermatozoa can be examined, their movements watched, and any abnormal constituent of the fluid observed. For greater detail it is necessary to make a film and examine with an oil-immersion lens. In abnormal forms such as small heads, broken necks, indistinct outline, variations of the size of the tail, or scanty numbers, there is no doubt that fertility is well below normal. The least important departure from normal is mobility, for it largely depends upon the time which has elapsed since ejaculation, and whether the specimen was allowed to cool in transit.

Insemination. In normal coitus the erect organ comes in contact with the cervix and the stream of semen is sufficient to fill the fornices and cover the cervix and os uteri. The recovery of living spermatozoa from the cervix or vagina is proof of the man's virility and fertilising power and acquits him of any responsibility for the condition. In order to demonstrate living spermatozoa in the vagina it is necessary to undertake the examination within six hours of coitus, otherwise only dead spermatozoa may be found, proving nothing except that coitus has taken place. Spermatozoa maintain rapid movement so long as they

are kept at a suitable temperature and in a slightly alkaline medium, the normal vaginal acidity is more than neutralised by the ejaculation of a normal quantity of semen, but an excessive degree of acidity may serve to kill the spermatozoa. In practice, living spermatozoa are only recovered from the vagina if the examination takes place within six hours of coitus; but where coitus is preceded by a mildly alkaline douche they may be recovered in from twelve to thirty-six hours after the act. Spermatozoa may be recovered much more frequently from the cervical canal, and in these cases there is no doubt that both vagina and cervix are healthy, and the problem is reduced to a consideration of the endometrium, the tubes, and the ovaries.

When may a woman be regarded as sterile? There is a wide divergence of opinion as to the length of time which should elapse after marriage, in an infertile union, before sterility can be established. Matthews Duncan considered that sterility should not be diagnosed until 3 years had elapsed; he found that only 7 per cent of married women bear a first child after that time. Simpson considered that only after 5 years should childless women be regarded as sterile. There is, however, much more to be considered than bold statements about time. For instance, both the age of the woman and the man are important; the period of maximum fertility in woman is 20-25 years. Before that age she is relatively sterile, after that age the curve of fertility gradually falls to 35 years, and after 35 years it falls very rapidly. In man the period of maximum fertility is 20-30 years, it declines gradually between 30-40 years and very rapidly after that.

In my ante-natal department of 300 primigravidæ:

- (1) 65 per cent became pregnant in the first year;
- (2) 20 per cent became pregnant in the second year;
- (3) 9 per cent became pregnant in the third year;
- (4) 6 per cent became pregnant more than three years afterwards.

If contraceptive methods were excluded it is highly probable that No. 1 would be increased at the expense of 2, 3 and 4.

Therefore, the test of fertility in a woman is the rapidity with which she conceives after marriage when both male and female are normal. I think then we may fairly say that any woman living a normal married life, desirous of having a child, and who has not become pregnant within a year of marriage, must be regarded as relatively sterile, and should

be investigated with the utmost care; for we know that the longer they remain unfertilised the more likely are they to remain so. There is no more difficult problem than the woman married 4-5 years, anxious to become a mother, yet remaining sterile. In my own practice I make it a rule thoroughly to investigate every case, both husband and wife, when they come before me wondering why the woman has not become pregnant, however short a time has elapsed since marriage. In the early days with useful advice or some simple measure of interference the object may be accomplished, whereas later it may prove a most difficult matter. At this time the examination is directed to ascertain whether there is any gross lesion present and as to the condition of the seminal fluid. If the result is satisfactory, a more detailed examination may be postponed for six months.

The investigation of the husband is directed to two points:

- (1) The presence of normal spermatozoa in the seminal fluid; when absent, the investigation of the woman need be carried no further.
- (2) The power of delivering the semen into the vagina. If this is absent it may be due to failure of erection, incomplete erection, deformity of the penis, or stricture of the urethra. The test of this is the recovery of spermatozoa from the vagina or cervix.

I have reports upon 400 men, and of them:

118 were completely sterile=29.5 per cent.

12 were relatively sterile=3.0 per cent.

The causes were numerous: epididymitis, tubercular testes, undescended and atrophic testicles, hypospadias and X-ray work. The importance of this knowledge lies in the necessity for examination of the husband before submitting the woman to an elaborate investigation and possibly operation. In many of these cases of male sterility the woman had been operated upon: hymenectomy, dilatation and curettage, incision of the posterior lip of the cervix, and laparotomy for retroversion of the uterus. Needless to say, none of them became pregnant and few of these operations would have been done had the husband's condition been ascertained beforehand.

CAUSES OF STERILITY

(1) Congenital. (2) Acquired. (3) Functional.

(1) *The Congenital Group* is divisible into two sub-groups :

(a) Absolute. (b) Relative.

(a) *In Absolute Sterility* the woman, owing to grave defects in the development of the genital organs, cannot become pregnant owing to the absence or maldevelopment of the ovaries, uterus or vagina. These conditions require no consideration since no treatment is of any avail.

(b) *The Relative Group* in which suitable treatment may enable them to become pregnant: Tough or unruptured hymen: Stenosis of vagina: Lesser degrees of under-development of the uterus including flexions and stenosis of the os uteri.

(2) *Acquired Sterility*, in which the patient has undergone some pathological process which hinders or prevents conception. This group includes secondary or one-child sterility, and is due to injury or destruction of any part of the genital tract: Infection of the genital tract: Displacements of uterus and ovaries: New growths of ovaries, tubes, uterus or vagina.

(3) *Functional Sterility*, in which the woman is potentially fertile and when placed under favourable circumstances becomes pregnant. This is frequently associated with ignorance of coitus; impotence; vaginismus; dyspareunia; dysmenorrhœa; too frequent coitus; incompatibility; frigidity; profluvium seminis; malnutrition; cessation of ovarian function; combined relative sterility and endocrine deficiency.

I have already pointed out that in 100 cases of sterility 30 per cent will be found to be due to the male.

In the 70 cases not due directly to the male :

32 per cent are cases of relative sterility ;

29 per cent are due to pelvic infection ;

20 per cent are cases where both male and female appear normal ;

10 per cent are due to developmental errors of uterus ;

5 per cent are associated with fibroids or ovarian cyst ;

4 per cent are cases where the woman is apparently normal, the condition of the man being unknown.

These figures bring fractions to round numbers.

MALDEVELOPMENT OF UTERUS

(a) *Arrest of development during intra-uterine life* includes cases in which no cervix or uterus can be recognised on bimanual examination, or cases in which the cervix is so poorly developed that it is represented by a dimple in the vaginal vault, and the body of the uterus by a small nodule above it. This condition is associated with primary amenorrhœa, and the patient remains completely asexual with no prospect of pregnancy.

(b) *Infantile uterus* in which the uterus develops normally in intra-uterine life, but growth ceases at the infantile stage and does not develop at puberty. The cervix is twice the length of the body, is small in comparison with its length, and tends to be conical with a pin-point os. These patients have irregular scanty periods, with or without dysmenorrhœa. The prospect of pregnancy is poor, but occasionally they become fertilised, and are evidently cases of delayed development in which the body of the uterus has resumed growth under the stimulus of sexual intercourse.

(c) *The small acutely flexed uterus with a conical cervix* and small os associated with primary dysmenorrhœa and scanty periods, more or less regular each month and lasting one or two days. These cases usually come under observation for dysmenorrhœa a year or so after the onset of puberty and are intractable to treatment. Later, they come for sterility. These are the patients who are not infrequently treated by dilatation of the os, intra-uterine stems, shortening of the round ligaments, and varied operations upon the cervix, procedures which will be discussed later.

Both man and wife apparently normal. There were 20 per cent of cases in which the spermatozoa were normal and deposited in the vagina. The woman was normal on physical examination, and her tubes were patent to CO₂. It must be borne in mind that despite our diagnosis of normality we are still ignorant of the physical condition of the ovaries. I have operated upon many of these patients and found the ovaries closed in by adhesions ; in others the tunica albuginea has been smooth

and firm but so thickened as to prevent ovulation taking place ; in a third variety the ovary is studded with small luteal cysts. The first of these conditions offers a reasonable prospect of success in cases where the ovary can be disengaged from its position without much injury or the production of raw areas. Excision of a part of the ovary in the last two conditions is sometimes successful.

Ovarian Cysts. In cases where there is complete destruction of both ovaries by tumours or abscess, absolute sterility is present. With cysts, however, there is almost invariably a rim of ovarian tissue which maintains the hormonal function even though it may be useless for ovulation, and at the operation the remnant of ovary discourages the hope of pregnancy ; nevertheless, that same ovary may present an almost normal appearance when seen a year or two later. I had one case of pregnancy after the excision of bilateral cysts in which there was so little ovarian tissue left that I had informed the patient there was no hope of pregnancy. Furthermore, a unilateral ovarian cyst seems to have a restrictive influence on conception—in four cases of one-child sterility the patients became pregnant within three months of operation for removal of the cyst.

Fibroids. The association of fibroids with sterility is well recognised, but is only the cause when the fibroid is so situated as to influence the endometrium. Myomectomy is in suitable cases a very successful operation. I have had six cases of pregnancy following this operation.

Pelvic Infection (29 per cent) is the most frequent cause of sterility in women, and includes the one-child sterility. In some cases the tubes and ovaries are entirely disorganised and the patient is absolutely sterile. In other cases the stress of infection falls upon the peritoneum, leaving the tubes patent but entirely burying the ovaries in a mass of adhesions ; these cases are suitable for operation. One-child sterility implies a woman who has borne one child and then remains sterile. These patients require the same investigation as cases of primary sterility, for although the cause may be infection following labour, there is always the possibility that the husband has had an attack of gonorrhœa and is azoöspemic. Similarly the woman may have cervicitis, endometritis, salpingitis, or pelvic peritonitis. These instances of sterility should invariably be investigated by inflation, lipiodol, and even laparotomy, for remediable causes are frequently found.

Laceration of the cervix is common in labour, and in itself does not

prevent pregnancy, but when associated with infection it frequently does so. Unfortunately, infection of the cervix is frequently associated with infection of the tubes and peritoneum.

Woman normal, man unknown. These were cases in which the men finally refused to be examined, but the women were determined to ascertain whether they themselves were normal. A complete examination was carried out, including inflation and lipiodol where indicated, but no operation was performed to ascertain the condition of the ovaries, and to that extent the proof was incomplete. In these cases we may assume that the man had experience of venereal disease and that he was probably deficient. In ordinary cases the investigation of the woman ceases at the bimanual examination until a report has been obtained on the condition of the man.

Retroversion and flexion of the uterus are regarded by many writers as a frequent cause of sterility, hence the common use of pessaries. Many surgeons are content when they have diagnosed a retroversion, and imagine they have determined the cause of the sterility. They proceed to replace it if possible, prop it up with pessaries, or advocate operation for the purpose of correcting what is assumed to be a mal-position. Retroversion without dyspareunia is rarely a cause of sterility; with dyspareunia coitus may be prevented so that there is no chance of conception. In a large number of cases of retroversion there were only twelve in which I concluded that the position of the uterus was related to sterility, and these were cases of complete retroversion with the body of the uterus in the pouch of Douglas. Four of these became pregnant with the proper use of a Hodge's pessary, three remained sterile despite the use of a pessary, and five were operated upon for restoration of the uterus to a more normal position.

Two conditions have to be differentiated :

- (1) Fixed retroversion. (2) Mobile retroversion.

(1) *Fixed retroversion* is almost invariably due to pelvic infection which has involved the uterus, tubes and ovaries, and it is highly probable that not only is the uterus fixed but that the tubes are closed and the ovaries buried in adhesions. In this type of case it is clear that the position of the uterus plays no part in the problem.

(2) *In mobile retroversion* the cervix may look backwards as usual, it may point down the canal, or it may lie against the anterior vaginal wall looking forwards. This last position is less favourably placed

than the first two for meeting the stream of semen poured out during coitus, and to that extent it may be regarded as a contributory cause of sterility. It is certain however that, provided the man and woman are of normal fertilising power, this is not sufficient to prevent conception, for women with congenital retroversion commonly become pregnant and sometimes come under observation between the third and fourth month for pelvic pressure symptoms. Nevertheless, in extreme retroversion the replacement of the uterus results in pregnancy sufficiently often as to justify the procedure in cases where investigation has shown the patient to be otherwise normal. Where retroversion is associated with an enlarged and unhealthy uterus, the cause of the sterility lies in the pathological condition of the uterus and not in the position of the organ, and replacement will not relieve the condition unless the associated endometritis is relieved at the same time.

In some cases the retroversion does play a considerable part in the temporary blocking of the tubes. I have operated upon two cases where inflation to 300 mm. Hg. failed to produce a pneumo-peritoneum, and in each case the obstruction in the tube was confirmed by lipiodol and found to be in the region of the junction of the isthmus and ampulla. In both cases I opened the abdomen, having previously passed the uterine tube, and when the pelvis was fully exposed and filled with saline for the detection of escape of gas from the fimbriæ, the gas was turned on and up to the limit of 300 mm. Hg.—no gas escaped. In both patients when the uterus was lifted forward from the position of extreme retroversion, the gas flowed at once and continued to do so at a pressure of 120 mm. Hg. Therefore it should be a rule that in cases of retroversion negative inflation should not be accepted until it has been carried out with the uterus replaced.

Prolapse is usually the result of labour, and therefore can only have a bearing upon secondary sterility. Prolapse in itself is not a cause, for we meet cases of pregnancy in women with *procidencia*, but it hinders coitus and may even prevent it. The sterility which is associated with prolapse is due to the condition of the vagina, which is invaded by organisms from the anal canal producing a chronic cervicitis and vaginitis, conditions which are inimical to spermatozoa.

FUNCTIONAL STERILITY

Ignorance. Among the more uncommon causes of functional sterility is complete ignorance of the man and the woman of proper

coitus ; in my practice I have seen numerous instances of it. The woman who presents herself for sterility reports that she lives a normal married life. On examination the hymen is not only intact but the entrance to the vagina does not permit the little finger to pass, and there is no vaginismus. Upon inquiring for details of coitus, the patient will describe interfemoral coitus which has taken place once or twice a week quite regularly since marriage.

One patient, aged 42, had been married for twelve years and penetration had never taken place, although she maintained that sexual intercourse had occurred regularly once a week ; but it was clear from the description that the penis was merely between the thighs. In another case a girl, aged 26 years, married five years, of normal physique and character, had had intercourse in the same way.

Pregnancy, of course, may ensue from the deposition of semen upon the vulva, but the chances are small and remote.

Some of these women realise that all is not well, for they tell us that proper intercourse has not taken place. These cases merely require a short explanation to both husband and wife, and where no other cause exists pregnancy should ensue as it did in three of my cases. In some, however, we ascertain that no proper intercourse has taken place owing to impotence in the man ; he either does not have an erection at all or he has a semi-erection with premature ejaculation. In another case the penis was no larger than a prominent clitoris and could only just touch the entrance to the vagina, although otherwise the man was six feet in height and well-proportioned. In complete male impotence there is no prospect of producing pregnancy by him and he should be referred for the opinion of a genital surgeon. In the other two types the question of a penile support or of artificial insemination will have to be considered.

Impotence in the female. Vaginismus. This is the condition where penetration of the penis into the vagina is impossible. There are two varieties :

- (1) Physical obstruction.
- (2) Nervous obstruction.

Physical obstruction. Tough or imperforate hymen, imperfect canalisation of the lower end of the vagina, adhesions between the labia, hypertrophy of the labia, strictures, injuries and duplicate vagina, tumours of the cervix filling up the vagina ; or inflammatory conditions such as vulvitis and cysts of Bartholin. The treatment of these conditions is entirely surgical and will be dealt with later.

Nervous obstruction. In this variety there is no organic obstruction, but the attempt at coitus produces such painful muscular spasms as to preclude the possibility of the act being accomplished. This is impotence in the woman. Vaginismus is fortunately a rare cause of sterility; there are only nine in my series of cases, for when present it is a complete bar to coitus and conception. It is a nervous condition in which the stimulus of fear throws into painful spasms all the muscles which contract in defence of virginity. The muscles of the vulva, vagina, the perineum, the adductors, extensors and glutei are all suddenly contracted and the patient may roll or throw herself off the couch. Examination and inspection of the genitalia are only possible under complete anæsthesia, and dilation or enlargement of the entrance to the vagina is rarely of any avail for curative purposes. It is associated with frigidity and abhorrence of sexual intercourse, and not infrequently with evidence of endocrine deficiency and arrested development of the uterus. These patients should be treated on psychotherapeutic lines, and referred to a physician for the purpose. A less serious form of vaginismus is sometimes associated with local lesions; the most common is trauma following a clumsy or violent first coitus which results in inflamed tags of hymen, and lacerations and fissures of the urethra, fourchette or anus, which produce the pain and result in muscular spasms. This form of vaginismus is usually relieved by appropriate treatment.

Excess of coitus. Too frequent coitus is perhaps the commonest cause of delayed pregnancy in early married life, where no precautions are taken to prevent pregnancy. Coitus may take place once, twice, or even more often in the twenty-four hours, and this very soon leads to a condition of azoöspemia. When this is established there is no prospect of conception until after a prolonged rest. It is therefore important to realise that absence of spermatozoa is not essentially permanent, and the semen should be examined on several occasions at intervals, during which time the man should be forbidden coitus.

PREVENTION OF CONCEPTION

One of the most striking social changes of this generation is the frequency with which a young couple about to be married discuss their arrangements for avoiding pregnancy in their early married life; and it is no uncommon experience for a consultation to be arranged with the sole object of obtaining advice on this matter. Should we decline,

there are so many irresponsible books and pamphlets published, that the young couple have no difficulty in coming by the knowledge they require. Indeed, they are frequently already primed with the knowledge of half a dozen different methods and have merely come to ascertain which is the most reliable.

The importance of this education was brought home to me by a young woman who had been married a year. She and the husband had agreed there was to be no pregnancy for some years. Being American she was thoroughly up-to-date and had a gold button introduced into the cervix immediately before marriage. She was sent to me for profuse vaginal discharge streaked with blood and recent severe dysmenorrhœa. On examination, there was so much œdema of the vagina and cervix that little could be made out, and she could not tolerate the passage of a speculum. Under an anæsthetic, after considerable difficulty the head of the button was found buried in granulation tissue with extensive induration of the peri-cervical tissues. When the button was removed, it was followed by a gush of dark blood and pus which had apparently been held back in the uterus. Later I had to perform a plastic operation on the cervix in order to restore the patency of the canal.

The question whether persistent prevention induces permanent sterility is difficult to be dogmatic about, but I am inclined to change my former opinion and now to regard it as probable; for a number of these patients, who respond satisfactorily to all tests, remain sterile. This is not irrefutable proof, but it is the impression gained from a very large experience. Coitus interruptus is certainly the commonest method adopted, and except that it may lead to temporary azoospermia it has no apparent deleterious effect upon the female genitalia. There is no question that excess may produce a serious general effect upon the woman in the form of irritability and neurasthenic symptoms, but if not carried out too long, and provided her pelvic organs are normal, she may conceive under favourable conditions. Sheaths can only be responsible for sterility inasmuch as oligospermia may be induced, but this method can scarcely affect the woman.

When we come to the use of strong drugs, whether as pessaries or douches such as quinine, lysol, alum, Milton or potassium permanganate, we have a very different problem. After persistent use there is clear evidence of the effect produced; the walls of the vagina may be dry and hard, or there may be an excessive discharge from a congested and swollen cervix, conditions which persist long after the cessation of the practice. These are conditions under which the spermatozoa do not survive long and are therefore responsible for sterility.

Profluvium Seminis is a symptom frequently volunteered in the history, and can be elicited from 95 per cent of patients. It is a natural

phenomenon and therefore of small importance ; for when we remember that the vagina is only a potential cavity, the walls being normally in contact, it is not surprising that the deposition of such a quantity of fluid, as occurs from a normal man during coitus, should be forced out when the vaginal walls collapse after the withdrawal of the penis. Advice to the effect that the woman should recline with her pelvis at a higher level than her head in order to counteract the escape of semen is of no value, for this would take place even though she stood on her head. Any treatment undertaken to deal with profluvium seminis means that the observer has not understood the problem he is attempting to solve ; for if it be the sole explanation of a particular case of infertility then the whole problem should be reviewed, for it is not the cause. While it is true that a quantity of semen is forced out of the vagina after coitus, there is sufficient left to impregnate half a dozen women if there be no abnormality present. It is surprising to find that some writers advocate narrowing of the vaginal entrance, or repair operation for this condition ; if done successfully it must militate against the condition which it was intended to relieve, since restoration of tone to a contractile organ like the vagina must render it more efficient in completely collapsing after coitus and thus squeezing out more fluid. This argument does not apply to complete or very extensive perineal tears.

Dysmenorrhœa and Sterility. Dysmenorrhœa is present in some degree in about half the women who come under observation for sterility. The severe primary form is not infrequently associated with a measure of maldevelopment of the uterus as shown by acute flexion, small uterus, conical cervix, pin-point os, and sterility. In these cases the dysmenorrhœa and the sterility are symptoms of under-development, and there is no causal relationship between them. The treatment of this condition is very uncertain, and the hope of a late development of the uterus, whether spontaneously or following the administration of the various endocrine glands, or the irradiation of the ovaries or pituitary gland, offers a poor outlook. Diathermy and vibro-massage of the pelvic organs are employed in Germany with the object of producing congestion, but the results offer no encouragement. In the mild degrees of arrested development a thorough dilation of the os and cervical canal succeeds in relieving the painful menstruation and the infertility sufficiently often to justify the procedure, but it should only be undertaken after the husband has been proved normal. There is no doubt that if any of these methods are to succeed, the earlier they

are undertaken after marriage the more likely are they to prove efficacious.

In secondary dysmenorrhœa, which is also associated with sterility, the cause is generally infection or new growth with the symptoms of dysmenorrhœa and sterility.

Membranous dysmenorrhœa is the passage of an endometrial cast of the uterus associated with severe pain of the congestive type and sterility. It is fortunately a very rare condition, for although sometimes relieved by dilatation and curettage, more often no relief at all is obtained.

Cessation of ovarian function during the child-bearing period of life renders the patient absolutely sterile. Such cessation may be temporary or partial as during pregnancy and lactation, or permanent when the ovaries are removed surgically or destroyed by disease.

Temporary cessation takes place in debilitating illness, lowered nutrition, myxœdema, etc., but the function is restored with appropriate treatment. The amenorrhœa which accompanies lactation, though usually temporary, may be permanent where the mother has nursed her child too long and the womb has atrophied. With the object of warding off another pregnancy these patients persist in feeding the child, until thoroughly exhausted they have to stop. After some months treatment they are restored to normal, but a small proportion have undergone a permanent menopause and are sterile. Such patients should be given complete sexual rest, a rich diet, a prolonged course of calcium salts, and small doses of thyroid extract.

Permanent cessation, apart from disease or removal by surgical means, is often associated with drug addiction, poisons, and obesity. One of the more recent causes is irradiation by radium and X-rays, which quickly destroys the tissues of generation in both ovaries and testes, and workers in the laboratories should be adequately protected.

Lack of Sexual Feeling—Frigidity—Anæsthesia sexualis. A large proportion of women who come under observation for sterility allow that they have no sexual desire, and experience no satisfaction from coitus but submit to it as the only means of becoming pregnant. In my experience there was total absence of sexual desire in 25 per cent of cases, while in a further 20 per cent although a desire for coitus was felt at or near the period no orgasm was observed. This absence of sexual

desire does not give rise to a condition of absolute sterility in a woman whose generative organs are normal, but it does unquestionably place them in the category of relative sterility, for it leads first to infrequent coitus and later to complete continence. Coitus takes place without reference to the menstrual cycle, and induces such repugnance that the act is often incomplete. This aversion is not infrequently induced by some unfortunate habit or condition in the male; and in cases where such a cause exists careful inquiry may elicit the information with the consequent correction of the trouble. We know that many women who have borne children experience no sexual feeling at all, and therefore we may conclude that frigidity is not an absolute cause of sterility. It is frequently associated with the small acutely flexed uterus and conical cervix, and is merely a symptom like the associated dysmenorrhœa. Frigidity is normal before puberty and commonly after the climacteric. It may be associated with a large discrepancy in size between the male and female parts. Extensive laceration of the vagina and perineum in labour will produce a similar effect. Coitus interruptus when carried on for any length of time may produce frigidity. Masturbation may have preceded this condition. Intellectual frigidity is a well-recognised variety where mental exercises have been pursued at the expense of the physical welfare. Abnormalities and injuries of the clitoris are rarely found in cases of frigidity; cases of rudimentary and webbed clitoris are seen fairly frequently, but they are rarely associated with anæsthesia sexualis, whereas injuries to the constrictor and bulb of the vagina following labour are frequently present with complete indifference to the sexual act. Persistent masturbation exhausts the sexual centres, so that the ordinary stimulation of coitus is not sufficient to activate them.

The treatment of this condition is most important, for it frequently ends in sterility and often in a drifting apart of husband and wife. It is not at all promising, and in the first place any physical cause such as lacerations should be remedied where possible. In the next place the knowledge of both man and wife of the sexual act should be reviewed; for nothing is more surprising than the number of these patients who have what they consider normal intercourse when the orifice of the vagina will not admit the tip of the little finger. Having considered the mental and gross physical defects, the general habits of both must be considered, such as out-of-door exercises and games. The various preparations of ovarian glands, mixed glands, and soluble hormones are strongly advocated by some authors, but in my experience they are only of value in a small proportion of cases, and each patient will

need to try most of them before a decision is taken that they are of no value.

Drugs like strychnine, iron, phosphorus and quinine have a useful place in treatment, for they help the patient generally though they may fail in the desired direction. Yohimbine hydrochloride, 1 cc. of a 1 per cent solution injected hypodermically twice a week over a period of six weeks, has proved successful in suitable cases. It is supposed to act by determining an increased flow of blood to the genital organs. Pituitrin has also given some measure of success. These drugs appear to be quite useless when given by the mouth.

Absence of orgasm differs from frigidity inasmuch as the woman experiences a desire for coitus, but there is no climax or orgasm, and consequently no satisfaction or pleasure, and this may ultimately end in frigidity. These patients not uncommonly admit to an orgasm during masturbation but are void of it in coitus. Coitus interruptus and impotence or partial impotence in the male are common causes of this condition. Frequent intercourse with an unsatisfied sexual appetite brings on a condition of hysteria and sexual neurasthenia, with symptoms of backache, leucorrhœa, chronic cervicitis, and endometritis. German writers maintain that an active participation on the part of the woman in coitus has an important influence upon the attainment of conception; this influence is exerted in two ways, it causes certain changes in the cervical secretion which facilitates the transit of the spermatozoa, and secondly there is a slight descent of the uterus which favours the entrance of the spermatozoa into the cervical canal. The treatment is not very satisfactory, but a sexual holiday of 4-6 weeks coupled with treatment, as for frigidity, may help matters.

Dyspareunia, or painful coitus, is frequently mentioned by the patient seeking relief for sterility. It is not a cause of infertility except that it may be sufficiently severe to prevent coitus absolutely, or only permit it rarely and incompletely. The conditions which cause painful coitus are hysteria, local hyperæsthesia, disproportion between the penis and vagina, trauma, the result of rough attempts at coitus, genital deformity or maldevelopment, cicatricial contraction, prolapsed ovaries, infection of urethra, cervix, uterus, tubes, ovaries, or peritoneum; urethral caruncle, fissure in ano, calculus in bladder, pelvic tumours, and degenerations like kraurosis vulvæ.

Dyspareunia is only a symptom, and the cause must be determined. There are a number of cases where no cause can be discovered, and

while they do not suffer the amount of discomfort and disturbance produced by vaginismus, yet the pain is sufficiently severe to preclude vaginal examination, save with the aid of an anæsthetic. Disproportion between the size of the penis and vagina is occasionally found, and it may occur in perfectly normal people who happen to be outside sizes mated together, or it may be due to some narrowing and shortening of the vagina. In extreme cases coitus is impossible; in several of my cases this was so, and operation was necessary to relieve it; in milder cases gradual dilatation with glass dilators succeeded. Dyspareunia associated with organic lesions is dealt with elsewhere under Treatment, but the variety met with in retroversion with prolapsed ovaries requires notice. In these cases the pain is due to the prolapsed and congested ovaries, which is proven by the relief of the condition when a pessary supports them in a more normal position. But when dealing with sterility the objection to pessaries must be considered, and the patient should be submitted to some form of suspension operation.

Obesity. The association of obesity with infertility has long been observed. Kisch analysed 215 cases of obesity and found sterility present in the ratio of 1 in 5, whereas he found the general ratio was 1 in 10. He expressed the view that the extensive deposition of fat hinders the normal development of ova. This is hardly tenable so far as a deposit of fat in the ovary is concerned, but it probably has a marked influence through general metabolism. This question of obesity must be considered from two aspects: (a) where it is due to excessive intake; (b) where it is due to endocrine deficiency.

Many fat women conceive and have large families during the favourable age of fertility, but probably close the fruitful period earlier than is usual, though while the ovarian function is normal they readily become pregnant. In cases where they become of such a size as to make coitus a physical difficulty, they cease bearing, not because they are sterile, but because coitus does not take place. In cases where obesity is regarded as the cause of sterility, appropriate treatment frequently succeeds. Strict diet which excludes fat, sugar and starch, adequate exercises with a course of massage and the Bergonié treatment will soon remove a large part of the excessive tissue. A better way, for the well-to-do patient, is to have a course of treatment at Vichy, Harrogate, or other suitable spa where the regime is strict and the discipline good for the unbridled appetite. I have a patient who has now had three children, but each time before she became pregnant she had to undergo a course of treatment for obesity.

In the second form of obesity due to endocrine deficiency, the deposit of fat is merely a symptom and is commonly associated with a small uterus, amenorrhœa, or irregular scanty periods and other signs of deficiency. These patients have never been pregnant and have little chance of it. They are usually treated with the various glandular products, of which the extract of thyroid appears to be the only one which has any effect at all. Stimulation of the pituitary gland and ovaries by means of X-rays improves some of them, but whatever measures are taken it is necessary to adopt the means already mentioned under the first group, if any benefit is to result.

Incompatibility or Selective Sterility. This is the condition in which a man and wife, both presumably normal and fertile, fail to have a child, although one or both on remarriage succeed in procreation. It is more than doubtful whether such a variety of sterility exists, for none of the cases quoted in support will bear critical examination. If this description is applied to a marriage where both the man and woman are relatively infertile, for instance, where a man with few and weak spermatozoa is married to a woman with scanty and irregular periods, then undoubtedly incompatibility or selective sterility exists, and if these partners were re-sorted and each met a mate of high fertility, pregnancy might follow. The term incompatibility is ill chosen to describe this condition, and selective sterility is much more accurate and appropriate. The classical example usually quoted is that of Josephine and Napoleon: the former had two children by her first marriage but remained barren to Napoleon: the latter subsequently had a child by his second wife. There is room for fallacy in most of these cases and particularly in the one just mentioned, for Josephine was 38 years of age when she married Napoleon, a time when fertility is fast ebbing, and it is more than probable that her uterus was in a condition of chronic metritis, for it is known that she had an extreme degree of oral sepsis and, moreover, she may have become sterile through infection after her second labour. Therefore we must conclude, even if Napoleon's success in his second marriage were above suspicion, that Josephine was relatively sterile at the time she married Napoleon. Gibbons states that he has observed cases of sterility in which the woman had no orgasm with her husband, but experienced great passion with a lover resulting in pregnancy. In some of these cases he knew the husband to be sexually normal, and in some cases which led to divorce the husband remarried and had children by the second

wife. Gibbons does not quote cases or give details, and so it is impossible to criticise his conclusions, but it is very difficult to satisfy oneself as to the evidence in the cases described as incompatibility.

It is safe to say that if we have arrived at this diagnosis, we had better review the whole case rather than rely on it. It is possible that such cases do occur, but they must be very rare. I have had a number of cases which supplied as much evidence as quoted above, but there is always a fallacy when closely examined.

I have met two cases in which I came to the conclusion that they were possible instances of incompatibility. In one a woman aged 28 had a child by another man before marriage to her husband. Four years passed and no pregnancy ensued. The husband was potent and of strong fertilising power; the wife was apparently normal in all respects, and I recovered living spermatozoa from her cervix. She was inflated and treated with lipiodol, both tubes being patent and normal. I opened her abdomen and found two normal ovaries, one of which had just ovulated. She remains childless.

In a second case a woman had two children by her first husband, with whom she always experienced sexual feeling. He died and she married again. The second husband was the father of an illegitimate child. The woman experienced no orgasm with him and did not conceive. She was normal physically in every respect, but the semen was not examined, so it was possible that he had become sterile.

Combined relative sterility. There is a considerable group of cases where one can find no organic cause for the infertility in either man or woman, yet nevertheless when we come to assess the clinical findings we are struck with the fact that functionally neither of them is normal. These are the people who have been labelled—Incompatible. In the male we are surprised to hear of the infrequency of coitus and his indifference to it: his semen contains spermatozoa, but they are comparatively few in number and cease movement sooner than one is accustomed to find in a vigorous specimen. A report upon these men often shows that they are of poor physique, the penis is small and webbed, the testicles are small and hang low and are sometimes associated with a varicocele, or perhaps one testicle only has descended into the scrotum, the other being in the inguinal canal. These are reports which are often made, and have no relationship to venereal or constitutional disease; they are just poor specimens of the race. It is impossible to say that these men are sterile for they have living spermatozoa though few, and if they were married to a healthy woman of normal fertilising power it is probable that conception would take place. Similarly when we sum up the woman we find that she is deficient in sex sense. She may be cold and experience no desire for coitus or orgasm, and consequently intercourse takes place infrequently; or she may be physically not pleasing, thin, sallow, and angular in some cases, or a little too plump with an

abnormal growth of hair in unusual parts of the body. The catamenia are regularly irregular, scanty, and associated with dysmenorrhœa. All these defects do not indicate absolute sterility, but they do place her in the class of relative sterility when the husband belongs to the same group.

Malnutrition. We are probably rarely consulted for sterility by anyone who is suffering from an actual want of food, but I am convinced that we are often consulted by patients whose diets are deficient in some respect or other; and I have been surprised to hear of pregnancies in which I had supplemented the diet but had given no other treatment. Gibbons quotes an experiment of the Highland Agricultural Society in which special food was supplied to sheep at the approach of the breeding season; the percentage of lambs born was greatest in the flock which had received the special diet. A further interesting observation was made, that if the special diet were given in excess fertility was lowered. Sampson Handley quotes the case of a large stock farmer in America who was threatened with ruin owing to the infertility of his stock. He imported fresh blood into his herds but to no purpose. On expert advice he mixed a small quantity of iodine with the drinking water of the cattle and the result was surprising, for his herds became normal in the number of pregnancies. There is no doubt that the vitamins play an important part in reproductive power, but there is no unanimity on specific details.

Clean good milk, meat, eggs, green vegetables and fresh fruit have special value. The richest among vegetables are lettuce, leeks, oranges, and tomatoes. The ear of wheat is particularly abundant in essential vitamins and is the main constituent of Bemax; the essential vitamin is present in bread made from whole meal and wanting in the white loaf made from fine meal; it is largely deficient in tinned and preserved food. This question of a suitable diet is of considerable importance to-day when we see the modern girl eschew proper meals in the effort to attain a sylph-like figure.

Drugs. The abuse of drugs like morphia, chlorodyne, cocaine and alcohol is responsible for sterility. These habits are found in two classes of women to-day: in young girls in the early twenties of a restless disposition, constantly seeking new stimuli or thrills and generally finding them in excessive cocktails or cocaine: secondly, in women of mature age nearing the menopause who find peace in morphia, chlorodyne or alcohol. The former, in my experience, have

generative organs which are under-developed, associated with a complete absence of sexual feeling and maternal instinct. Without any vices they would be problems in sterility, but with the incubus nothing can be done for them until the vicious habit is broken. The second group are women who have already borne one or more children but for family reasons are desirous of having an heir. They live lethargic lives, put on fat rapidly, and soon become repulsive objects, while the periods become more scanty, irregular, and finally cease. There can be little doubt that the mode of life and the intake of poison extinguishes the already failing ovarian function. There is also the possibility that they are examples of secondary sterility.

In one case of mine, the woman aged 37 years had borne five daughters, and it was of some importance that a boy should be born to inherit the estate. After the birth of the last child she had a prolonged illness, in which morphia and chlorodyne had been freely given. When she recovered she became an addict. Physically she was a perfect figure, her pelvic organs were normal, and the tubes were patent. The husband was also normal. She was treated by experienced physicians for the drug habit, but to no purpose, and despite all efforts she did not conceive again. The sole physical change was an increase of adipose tissue, the result of her indolent life.

The Investigation. The patient should be questioned about her menstrual periods, as to regularity and length, and whether she has pain at or between the periods, the presence of leucorrhœa, and whether it commenced before or after marriage; if she has conceived, details of the miscarriage or labour and subsequent convalescence, whether she has been treated before, and if so, what treatment was adopted. The past medical history, age at marriage, how long married, any family or constitutional disease, are all questions which may throw some light on the problem.

The age and description of the husband should also be ascertained; he should be interviewed and questioned on his early experience of venereal disease, if any. Information about his habits with regard to physical exercise, games, alcohol and nicotine should be sought. The question of coitus and whether associated with pain, pleasure, or desire; the frequency is most important, for it varies from once in two to three months to seven or eight times a week, the latter being the most frequent cause of delayed conception in the recently married. It is of the utmost importance to ascertain whether normal intercourse takes place, for though the reply is frequently satisfactory, when the vaginal examination is made it is clear that penetration has never taken place. Penetration is not absolutely necessary for conception to

abnormal growth of hair in unusual parts of the body. The catamenia are regularly irregular, scanty, and associated with dysmenorrhœa. All these defects do not indicate absolute sterility, but they do place her in the class of relative sterility when the husband belongs to the same group.

Malnutrition. We are probably rarely consulted for sterility by anyone who is suffering from an actual want of food, but I am convinced that we are often consulted by patients whose diets are deficient in some respect or other; and I have been surprised to hear of pregnancies in which I had supplemented the diet but had given no other treatment. Gibbons quotes an experiment of the Highland Agricultural Society in which special food was supplied to sheep at the approach of the breeding season; the percentage of lambs born was greatest in the flock which had received the special diet. A further interesting observation was made, that if the special diet were given in excess fertility was lowered. Sampson Handley quotes the case of a large stock farmer in America who was threatened with ruin owing to the infertility of his stock. He imported fresh blood into his herds but to no purpose. On expert advice he mixed a small quantity of iodine with the drinking water of the cattle and the result was surprising, for his herds became normal in the number of pregnancies. There is no doubt that the vitamins play an important part in reproductive power, but there is no unanimity on specific details.

Clean good milk, meat, eggs, green vegetables and fresh fruit have special value. The richest among vegetables are lettuce, leeks, oranges and tomatoes. The ear of wheat is particularly abundant in essential vitamins and is the main constituent of Bemax; the essential vitamin is present in bread made from whole meal and wanting in the white loaf made from fine meal; it is largely deficient in tinned and preserved food. This question of a suitable diet is of considerable importance to-day when we see the modern girl eschew proper nutrition in the effort to attain a sylph-like figure.

Drugs. The abuse of drugs like morphia, chlorodyne, cocaine and alcohol is responsible for sterility. These habits are found in two classes of women to-day: in young girls in the early twenties with a restless disposition, constantly seeking new stimuli or thrills and generally finding them in excessive cocktails or cocaine; secondly in women of mature age nearing the menopause who find peace in morphia, chlorodyne or alcohol. The former, in my experience, have

own series of cases the man was solely responsible in 30 per cent of the cases; why, then, should the woman be put to the suffering and inconvenience of the further steps of examination if the husband is incapable of fertilising her?

When the condition of the husband is found to be favourable, I proceed to examine the cervix and the vaginal discharge when abnormal. The secretion in the cervical canal should be tested for its chemical reaction, and a drop of the secretion examined under the microscope. A further examination of the cervical canal contents is undertaken within two hours of coitus, for after this time little or no information may be obtained as to the fate of the spermatozoa. In those cases where living spermatozoa are recovered I proceed to the next step, viz. inflation of the tubes, but where none are found the examination is repeated after the patient has used an alkaline douche of sodium bicarbonate and sodium chloride half an hour before coitus. If again negative, the cervix is painted with picric acid solution, and crayons of ichthyol and glycerine are placed in the cervical canal nightly for ten nights, followed by a douche of 0.5 lactic acid in the morning. At the end of three weeks post-coital examination is again undertaken, and when satisfactory the patient is referred for three months as a trial period; if no pregnancy ensues, examination of the tubes is undertaken.

Investigation continued. Inflation. Inflation of the uterus and tubes was first carried out by Rubin of New York, in 1919, and he elaborated the procedure and apparatus until the test became a clinical possibility. He first used it to determine the patency of the tubes, but later claimed it as a therapeutic measure with a 10 per cent success of pregnancies in sterile women. Rubin's apparatus was found to be too cumbersome for clinical use, and a much more convenient instrument is either Provis's modification of Currie's apparatus, or Reynolds' pocket insufflator, which is most convenient in the consulting room or if called upon to carry out the test in the country.

Provis's Apparatus (fig. 1450). The necessary parts are: (1) a sparklet of carbon dioxide; (2) a manometer; (3) a wide-mouthed jar for water in which is placed the volumeter (C); (4) a uterine tube. The sparklet (F) is placed in a holder (G), which, screwed up, drives a pin through the head of the sparklet. The carbon dioxide thus liberated is now controlled by a stopcock (H). When the stopcock is opened the gas flows through the rubber tubing into the volumeter (C) and thence into the jar which holds water. The jar is connected by two tubes, one

(D) to the manometer which registers the pressure, and the other or (E) to the uterine tube. The stopcock can be used to control the flow of the gas, which should only be allowed to flow slowly and evenly, so that the needle of the manometer mounts steadily. Before attaching the gas connection to the uterine tube, the apparatus should be tested to see that all joints are sound. This is done by pinching the rubber tube leading to the uterine tube and turning on the gas; if there is no leakage the needle remains steady.

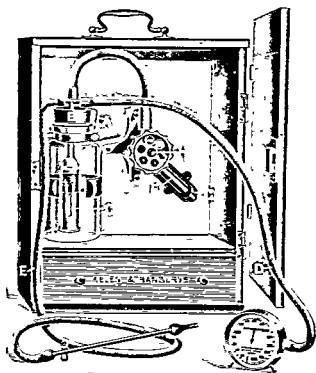


Fig. 1450.—PREVOST'S APPARATUS.

The uterine tube should be of a calibre not greater than No. 7 Fenton's dilator, and should have a curve which corresponds to the angle of the uterine sound. It should be blunt at the top and open by lateral eyes like the male catheter; a small male catheter, with a suitable collar to take the rubber tube, acts quite well. I was wont to use a uterine tube with a terminal opening, but there is the risk of engaging the point in the uterine wall and forcing gas into the small vessels. Some of these uterine tubes are fitted with cone-shaped plugs which are intended to engage in and plug the os uteri, occluding it and preventing the back flow of gas. This obviously defeats its purpose; it would be satisfactory to block an inelastic opening like the mouth of a bottle; but the more it is pushed into the os uteri the more the latter dilates and allows the gas to escape. A more efficient

way is to close the canal around the tube by moderate compression with a suitable forceps (fig. 1451).

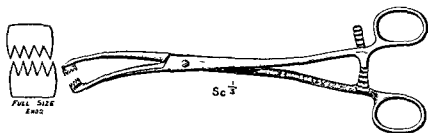


Fig. 1451.—AUTHOR'S FORCEPS.

Reynolds' Apparatus (fig. 1452). This apparatus for insufflation of the Fallopian tubes was designed to provide a small, compact, and easily portable outfit by means of which CO_2 could be used.

The apparatus measures $8\frac{3}{4}'' \times 3\frac{3}{4}'' \times 3''$, and can thus be carried in one's ordinary instrument bag without necessitating an extra and bulky case such as that required for Provis's instrument.

As the illustration shows, it consists of a holder for sparklet bulbs connected by a needle valve to a pressure chamber on which is mounted a manometer. From this pressure chamber a connection leads by

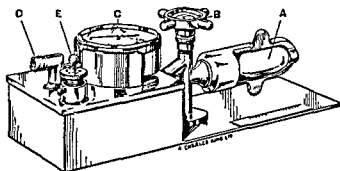


Fig. 1452.—REYNOLDS' APPARATUS.

rubber tubing to the uterine cannula. A relief valve is provided which can be set to any desired pressure. Should the supply valve be opened too fully and suddenly by any inexperienced assistant, this valve will immediately function and prevent the possibility of any accident from too high a pressure.

The whole apparatus is made of metal with the exception of the glass front to the manometer. It is simple in construction with nothing much to go wrong, and it is easy to use.

Reynolds has devised a forceps which helps to compress the canal and at the same time affords an attachment of support for the uterine tube (fig. 1453).

The twin vulsellum forceps was devised to enable the uterine cannula to be fixed in position with the cervix gripped tightly round it without the necessity of either cannula or vulsellum being held by the surgeon, whose hands are thus free for operating the insufflator or auscultating the abdomen should he so desire.

The forceps are separated and one applied to each lip of the cervix, after which they are re-connected by means of the telescopic crossbar. The cannula is then passed into the cervical canal and its stem placed between the plates of the clamp. Sufficient pressure is made upon the cannula for the conical end to block the canal completely, and the clamping screw is tightened up. By this means the cannula is held firmly in position.

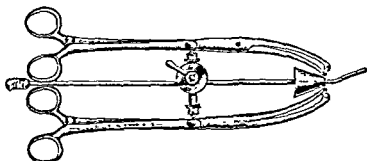


Fig. 1452.—REYNOLDS' FORCEPS.

If Forsdike's pattern of cannula is used instead of the conical-ended type, the cannula should be passed into the uterus and then a suitable grip taken of each cervical lip in order to close the cervix tightly round the cannula. The ball-and-socket joints on which each vulsellum is mounted provide free movement in any direction to enable a lateral grip of the cervix to be taken, which facilitates the complete closure of the canal. The cannula is then slid into the clamp and the screw tightened up.

Contra-indications. There are certain well defined contra-indications to the operation of insufflation :

- (a) There must be complete absence of pelvic infection or sup-puration ; no pelvic tenderness, irregular swellings or fever.
- (b) It must be carried out in the absence of uterine hæmorrhage, and at an interval from the menstrual period, thus avoiding any danger of air-embolism. I reported a case of an embolism in the *Lancet*, December 19th, 1925, which occurred in an out-patient. Fortunately I was proceeding slowly and carefully,

and at the first sign of difficulty I lowered the pressure in the uterus by disconnecting the rubber tube at the uterine joint, thus possibly averting a disaster. The patient recovered completely in a few hours and was discharged next morning from hospital.

- (c) It is important to exclude any grave cardiac lesion, for an unfortunate result might ensue from the passing of the uterine tube without the added stress of introducing gas into the peritoneal cavity.
- (d) Any advanced pulmonary lesions or other systemic disease would preclude the advisability of conception and therefore inflation should not be undertaken.

The production of pneumo-peritoneum was in the early days tested by an X-ray examination of the abdominal cavity ; but this is certainly not necessary as it can be proved by clinical signs. It was further claimed that the distribution of pain showed whether one or both tubes were closed, and if the pain were mid-line that the tubes were closed in the region of the cornua. It will be known to anyone who has had much experience of inflation that the tension pain complained of by the patient is generally referred to the hypogastric area, and she is never able to locate the pain to one or other side, still less to describe it as limited to or near the mid-line.

Fortunately the presence of a pneumo-peritoneum as proven by X-rays is only necessary in exceptionally fat women, where even though the pressure be raised to 300 mm. Hg. the gas only trickles in slowly. In ordinary cases by my technique it can be diagnosed with absolute certainty by percussion over the suprapubic area, by auscultation over both tubes when the bubbling of air is heard over one or both sides, by the flow of gas, and finally by the effect of the presence of gas under the diaphragm when the patient has assumed the erect position.

I do not hesitate to employ a pressure of 300 mm. Hg. provided the patient is conscious and tolerates it, and if once the pressure registers that point, then I know no further test is necessary ; the tubes are closed unless the uterus is in complete retroversion. It is a disadvantage to anaesthetise the patient, for it is not safe to exceed a pressure of 200 mm. Hg. if the patient is unconscious, and that pressure does not prove the tubes to be closed. Whereas if the patient is awake she does tell you all about the pain, and the pressure is adjusted accordingly. Gas may pass through normal tubes at any pressure from

40–120 mm. Hg., and there is never any doubt about the patency of the tubes at these levels. The needle of the manometer mounts steadily when the gas is turned on, and suddenly stops as it begins to fall when gas enters the peritoneum; if the pressure system has been adequately tested for leakage at joints before use, and there is no back-flow from the uterus, which can be demonstrated by filling the vagina with saline solution, it must have entered the peritoneal cavity. In other cases the pressure may rise to 200 mm. Hg. before the gas flows into the peritoneum; however, if it then flows freely it has no significance, but where it merely trickles through it is probable that stenosis of one or both tubes is present. In some cases the pressure may be raised to 300 mm. Hg. and the needle sinks slowly, showing there is no doubt that obstruction exists in both tubes and it is wise to proceed to the next step of investigation by means of lipiodol.

The Technique. A day is arranged to avoid the menstrual period, four or five days after the termination being a convenient and safe time. Glycerine plugs of gauze are introduced into the vagina on the night preceding the examination, and should be placed so as to be in contact with the cervix. The plug is removed next morning at the time of the examination. The patient is placed upon the table in the lithotomy position, the table being tilted slightly into the Trendelenburg position to make the pubic area the dome of the abdomen. The plug is removed, a Sim's speculum is passed, and the vagina and cervix are mopped with dry mops; the vaginal walls are then thoroughly painted with iodine. The cervix is fixed with a tenaculum, and the sound is passed followed by Nos. 1 and 2 dilators, and the uterine tube is introduced as far as it will go. The tube is then connected to the apparatus by stout rubber tubing, a layer of vaseline completing the security of the joint. The lips of the cervix are now pressed together by special forceps so as firmly to surround the tube. The vagina is filled with saline and if the gas blows back from the uterus it is immediately recognised. The percussion note over the pubic area is sounded repeatedly and memorised as far as possible. The gas is now turned on slowly and the needle allowed to rise steadily. When the needle begins to fall, gas is passing into the peritoneum. Auscultation over both ovarian regions will enable us to hear the hissing or bubbling of gas as it escapes from the Fallopian tubes, and it may be possible to tell whether one or both tubes are patent, but no value can be attached to the distribution of pain over the lower abdomen as to whether a tube is blocked or where is the site of the obstruction. When no gas passes at

a pressure of 300 mm. Hg. the tubes may be definitely regarded as closed, and if the uterus is not completely retroverted they are closed pathologically. To follow this technique it is essential to carry it out without anæsthesia, for it is only in a conscious patient that it is wise to use a pressure of 300 mm. The greatest safeguard of a conscious patient is pain; any hollow viscus placed under the tension causes intolerable pain, and the patient will complain when the Fallopian tubes are distended, and the conclusion may be safely drawn that the tubes are closed if and when that pressure is reached. With an unconscious patient an arbitrary pressure limit of 200 mm. Hg. is the maximum consistent with safety, and a negative result at that pressure tells you nothing.

Further evidence of the passage of gas into the peritoneum is yielded by the suprapubic percussion note which has now become tympanitic, and final evidence will be obtained when the patient resumes the erect position, for they complain of pain and pressure in the diaphragmatic area which is frequently referred to the shoulders.

It is important to use the minimum quantity of gas in obtaining the result, for a large quantity may blow up the abdomen like a drum; it is also necessary to keep the patient in the recumbent position for some hours. Even with small quantities she may feel discomfort and pain in the shoulders for 24-48 hours. With experience 40-50 cc. of gas will be found sufficient to obtain a diagnosis. If no gas passes, make sure the uterus is not in retroversion before concluding that the tubes are blocked.

Insufflation of the tubes may give rise to feelings of faintness and occasional vomiting, but these quickly pass off if the patient maintains the recumbent posture. Carbon dioxide is more rapidly absorbed than air and I find fewer complaints since I have been using the sparklet. With the small quantities of gas I now use, the patient is able to resume her activities within a couple of hours, and I carry out this procedure upon out-patients who return home as soon as they are dressed.

In cases where inflation fails, it is of importance to establish the seat of obstruction, for where the tubes are disorganised or the obstruction occurs at the uterine end of it, most surgeons will agree that operation holds out little or no hope, whereas if it can be shown that the tubes are patent as far as the fimbriæ, the chance of restoring the lumen by a suitable operation offers a reasonable prospect of success. Injection of lipiodol will reveal the site of obstruction.

Results of Inflation. In drawing conclusions from even a large number of cases it is not possible to exclude fallacies; nevertheless,

when we find a number of pregnancies occurring in patients who have remained childless despite a normal marital life, but who conceive after inflation, one is entitled to conclude that they stand in the relation of cause and effect. Rubin claimed 10 per cent of pregnancies as the result of inflation, my own series of cases shows 15 per cent of pregnancies. We have to remember that conception occurs in a small percentage of patients after dilation of the os alone, and as a degree of dilation takes place during inflation that may have some influence upon the results. We also have to remember coincidence; two patients married three and four years respectively consulted me for sterility. Inflation was postponed pending investigation of the husband; both became pregnant before further action was taken. The successful cases in my series varied in history from two to ten years, and conception occurred in the majority of patients within six months. It is my experience that six months is the limit of time in which pregnancy may be expected after inflation.

Investigation by Lipiodol. Lipiodol is a viscous oily compound of iodine 40 per cent, the opacity to X-rays being due to the iodine.

Contra-indications. Pelvic infection or suppuration as shown by swellings, tenderness or fever. Infections of the vagina or cervix. Grave cardiac or pulmonary disease.

The injection should be made between periods, and an aperient should be taken the night before to ensure the bowels being emptied, thus facilitating the radiogram. A glycerine plug is introduced into the vagina the night before in order to soften the cervix. The patient is placed on the table in the lithotomy position, the vagina and cervix are dry swabbed and thoroughly painted with iodine, and a Sim's speculum is passed. The uterine sound followed by Nos. 1 and 2 dilators are passed into the uterus. The uterine tube, which is attached by stout rubber tubing to a 20 cc. Record syringe, the whole system containing lipiodol up to the 10 cc. mark of the syringe, is now passed into the uterus as far as it will go and the cervix-forceps compresses the cervix snugly around the tube. The vagina is now plugged with gauze to support the tube and forceps and to prevent the escape of lipiodol on to the X-ray table. A practical point of importance is to tie the rubber joints at both the uterine tube end and the end attached to the syringe, as otherwise the oil may escape through the joints, and the procedure will have to be repeated. The patient is then transferred to the X-ray couch and the oil is slowly but firmly injected into the uterus,

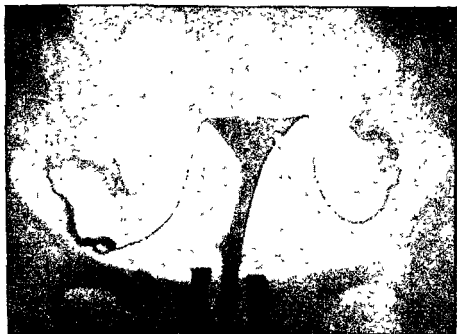


Fig. 1454.—HYSTEROGRAM SHOWING THE POSITION, DIRECTION AND APPEARANCE OF BOTH TUBES.

By permission of H. K. Lewis & Co. Ltd., from "Sterility in Women.")



Fig. 1455.—SHOWS ONE TUBE PATENT AND ONE CLOSED.

This photograph shows the uterus and right tube full of lipiodol. The left tube is only shown at the cornu, turning backwards, and is only patent at the point where it leaves the uterus. From this photograph one would say that neither tube was patent, for there is no lipiodol free in the peritoneal cavity. Patient, at 29 years, married 8 years, no pregnancy. Inflation, December, 1926. Lipiodol, December, 1927.

(By permission of H. K. Lewis & Co. Ltd., from "Sterility in Women.")

the flow of the oil being observed through the fluorescent screen, and when the patient complains of pain or the oil is seen to reach the pavilion of the tube a photograph is taken. Pain is complained when there is tension behind an obstruction, and it continues and intensified while the pressure is maintained or raised and is instantly relieved when the pressure is lowered. When pain is produced our object



Fig. 145b.—SHOWS BOTH TUBES CLOSED AT FIMBRIATED END.

The uterus and both tubes are shown full of lipiodol, and the vulsellum indicates the position of the cervix. The left tube is erect and characteristically clubbed, and is the most favourable for a plastic operation, the right tube shows up thoroughly, but is prolapsed and more irregular at the fimbriated extremity. There is no oil in the peritoneum, and the diagnosis, if made from this picture alone, would be both tubes closed, but it can only be made after taking another picture a few days later.

(By permission of H. K. Lewis & Co. Ltd., from "Sterility in Women.")

is achieved, for the oil has arrived at the seat of obstruction, and we can release pressure and take the radiogram. The radiogram shows us : (a) the position, appearance, and direction of the Fallopian tube ; (b) the exact site of obstruction, whether in isthmus or ampulla ; (c) the character of the lumen of the tube, and (d) whether an operation for relief of the obstruction is advisable, e.g. obstruction at the fimbriated end offers a reasonable chance of success, whereas obstruction at the cornual extremity offers the prospect of a forlorn hope. There

are precautions to be observed before concluding that the tubes are blocked—for instance, with a fully retroverted uterus no oil will get through. Again, it is often difficult to decide from the radiogram taken at the time of injection whether the oil has reached the peritoneum, and it is essential to take another radiogram in 24 hours' time



Fig. 1457.—SHOWS BOTH TUBES CLOSED AT CORNUA.

This picture shows the uterus and the commencement of the Fallopian tubes. The latter are blocked immediately after they leave the uterus, and of course there is no lipiodol in the peritoneum, nor was there when a second picture was taken a few days later. This is the type of case which should never be submitted to operation, for not only are the tubes closed at the point seen in the photograph, but they are also probably completely disorganised beyond it, and there is no hope of relieving the condition. I have operated upon three similar cases, only to find complete destruction of the tubes. Taken from a patient *at* 24 years; she was married when 15 years of age, and had her one child before she was 17 years of age; her labour lasted three days, and she was up and doing in ten days, but has never been pregnant since—7 years' sterility.

(By permission of H. K. Lewis & Co. Ltd., from "*Sterility in Women*.")

which will dispel all doubt. A further precaution necessary is an interval of a few days between a negative inflation and the injection of lipiodol, to give air imprisoned in a closed tube time for absorption.

Effects of Lipiodol. Lipiodol is completely absorbed in the peritoneum in 7–10 days, though in a closed tube a shadow may persist for many months, ultimately disappearing. For 2–3 days following injection there may be some slight uterine hæmorrhage, but it passes off without any general disturbance. That no peritoneal irritation is produced was shown in several cases where I opened the abdomen within



Fig. 1458.—BOTH TUBES CLOSED AND MALFORMATION OF UTERUS.

This photograph shows a malformation of the uterus due to incomplete fusion of the Mullerian ducts—Uterus bicornis unicollis. Both horns are well shown with large cavities, but the tubes are malformed, and they are both blocked, as was proven by a later photograph. This patient was stunted in stature, and had accompanying deformities of the pelvis and spine.

(By permission of H. K. Lewis & Co. Ltd., from "Sterility in Women.")

a week of the injection. In one case a pool of lipiodol was present in the pouch of Douglas, but the peritoneum was normal in appearance. In addition to the diagnostic importance of lipiodol there is a pronounced therapeutic effect, for pregnancy follows in about one-third of the patients who are normal physically, and may ensue up to a period of twelve months from the date of injection. These results are so good that I now usually eliminate inflation, and explore the uterus by means of lipiodol only. When lipiodol is being injected as a therapeutic measure 5 cc. will be sufficient for the purpose, but it is well to have 10 cc. in the syringe and to watch the flow under the screen. In my earlier cases I injected about 10 cc. and was only contented when I could see oil free in the pelvis, but this is quite unnecessary, for when the patient has been in the erect position for a little time the oil passes out of the Fallopian tubes into the peritoneum, and a radiogram taken then will show it to be distributed through the pelvic peritoneum (fig. 1459).

Treatment. Before undertaking any treatment of the woman which necessarily involves discomfort and pain, it is imperative to

remember that in 30 per cent of cases of sterility the male is infertile, and therefore it is useless to submit the woman to any kind of interference. An unreasonable proportion of the women who present themselves to me for sterility have already undergone various surgical operations, for instance, dilatation and curettage, plastic operations on the cervix, dilatation of the vagina, and Gilliam's operation, and some of them have been performed upon women whose husbands were infertile. It should, therefore, be regarded as an inflexible rule that the investigation of a case of sterility involves the examination of both husband and wife before expressing an opinion or undertaking treatment of the woman.

CONDITIONS OF THE VAGINAL ENTRANCE AND VULVA WHICH INTERFERE WITH COITUS

Obstruction to the vaginal orifice may be produced by an imperforate or rigid hymen which completely bars access. When the hymen itself appears normal, there may be a membranous septum immediately above it, giving rise to the same difficulty. This membrane is rarely



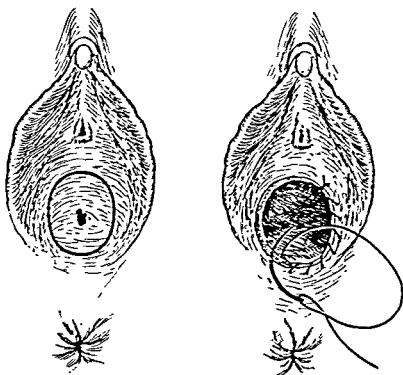
Fig. 1459.—SHOWS LIPIODOL DIFFUSED THROUGHOUT THE PELVIS.

A photograph of the same patient as fig. 1455 taken six days later. The oil is seen to be scattered throughout the pouch of Douglas and pelvic peritoneum; some of it remains in the right tube, but this can only be decided by a further photograph a week later, when the oil will have been absorbed from the peritoneum.

(By permission of H. K. Lewis & Co. Ltd., from "*Sterility in Women*,")

complete, but when it is it results in concealed monthly periods with hæmatrometra; it is generally sufficiently perforated to allow the catamenia to flow away.

As a rare form of obstruction there may be a membrane stretched across the upper part of the vagina. In this case the cervix cannot be seen until the diaphragm is excised.



A. Hymen almost closing the vagina.

Fig. 1460.

B. Hymen excised at its attachment to the vagina. A catgut suture is used to close the raw area.

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These membranous obstructions are frequently associated with some measure of stenosis of the entrance, and this is important, for mere excision of the occluding membrane may remove only a part of the obstruction, leaving the entrance so narrow as to prevent coitus.

The hymen (fig. 1460) or obstructing membrane should be excised under general anæsthesia, the incision being carried round the circumference, where it is attached to the vaginal wall; a catgut suture closes the wound in order to avoid the formation of fibrous tissue. Where a narrowing of the vaginal entrance is present, or relative narrowing, as in cases of pronounced disproportion between penis and vagina, a linear incision into the posterior vaginal wall and stitching the wound up in the transverse direction will effect the necessary widening. It is

most important that violent stretching and tearing of the tissues at the vaginal orifice should be avoided, for it is followed immediately by very painful coitus, and more remotely by the formation of fibrous tissue, which again narrows the entrance. A clean incision, with careful suture of the wound, followed by gradual dilatation with vaginal dilators, commenced three days after the operation and carried on daily, will end satisfactorily.

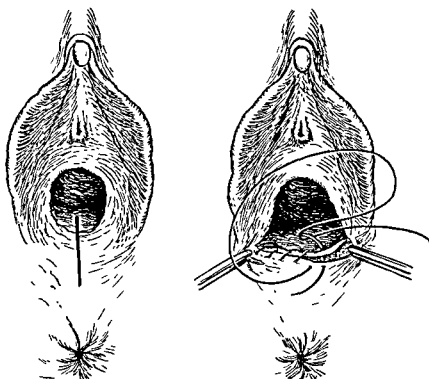


Fig. 1461.

A. Linear incision for widening the vaginal entrance.

B. The incision being stitched up transversely

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Fissures. Inflamed carunculæ myrtiformes, excoriations, etc., may be exquisitely painful, and so prevent coitus. It is a not uncommon condition in the early days of married life, when they may become infected with pyogenic organisms. Coitus should be stopped, and the patient advised to take mild antiseptic baths. Careful drying afterwards and the application of a little boracic ointment for ten days will restore the parts to a normal condition. In a few cases the hymeneal tags will need to be excised before the condition is relieved.

Urethral caruncle in the later years of life is responsible for quite a proportion of the patients suffering from dyspareunia. They generally grow from the lower end of the posterior wall of the urethra, and may

be sessile or pedunculated ; some of them are exquisitely tender to the touch, and even produce painful micturition. When the painful variety is present, coitus is impossible owing to pain. The treatment is surgical ; where possible the caruncle should be completely excised, taking care that the incision passes through normal mucosa on all sides of the growth, otherwise it not infrequently recurs within a few months. The healthy mucosa should be brought together with fine catgut sutures. In cases of sessile caruncle, where a radical excision may be inexpedient, the growth must be completely destroyed with a fine galvano-cautery point, care again being taken to exceed the limits of the growth and to allow sufficient penetration so that the deeper parts may be reached.

Vulvo-vaginitis and Bartholin's abscess are due to infection by various organisms, the commonest of which is the gonococcus. The swelling, œdema and pain prevent intercourse. The vulvitis and vaginitis should be treated by sitz-baths, douching, and drainage, with complete rest in bed. In cases due to abscess of Bartholin's gland, the abscess should be drained and the gland excised.

Maldevelopment of the uterus. Where the uterus is represented by a small mass of tissue, it is usually accompanied by primary amenorrhœa and defective secondary sexual characters, and there is no hope of relief.

In cases where the uterus remains in the "infantile state," in which the body is small but the cervix long, there may be scanty and irregular periods associated with dysmenorrhœa. A few of these cases are merely instances of delayed development, and may become relatively normal as late as the twenty-first year ; the majority, however, persist in the same condition throughout life, and are absolutely sterile. Any local treatment of this condition is of no avail, and attention must be devoted to the endocrine glands, either by way of administration of the various preparations of thyroid, ovary, pituitary, etc., or by way of an attempt to stimulate the glands with X-rays. It is well recognised that, with the exception of thyroid extract, these products are practically inert when given by mouth. There is some response to soluble products of the ovary given hypodermically, but the results are not constant and are therefore unreliable. However, in two cases in which I gave a course of injections of a water-soluble hormone of the ovary, the patients became regular each month with periods of 3-4 days where it had formerly been a 1-day show.

Stimulation by X-rays. (a) Pituitary. In six cases of maldevelopment of the uterus, three were associated with primary amenorrhœa, and three with scanty periods of 1-1½ days in 3-4 months. The three with primary amenorrhœa did not react at all; the other three improved considerably for a time, but then gave up treatment.

(b) Ovaries. Stimulation of ovaries by radiation requires a fine decision and most careful administration, for the margin between stimulation and destruction of these poorly functioning organs is a very narrow one. Two of these cases showed no response, and treatment was stopped. One case became regular each month for six months and then abandoned the treatment. One became regular and remained so, but as far as I know remains sterile.

One had been married nine years, was childless, and had never been pregnant. She had a small retroverted uterus with elongated cervix, scanty and irregular periods, with some pain. She had six exposures at about a month's interval between each dose. She gradually became regular each month of four days' duration, and the following year became pregnant and was later delivered of a normal son.

Rubin claims nine conceptions out of twelve patients treated in this way.

In the lesser degrees of under-development, such as we find associated with a small acutely flexed uterus, conical cervix, and small os uteri, a condition which is reflected in regular but scanty periods, dysmenorrhœa, and sterility, numerous operations are recommended. The object of these operations is twofold: (a) the dilatation of the cervical canal, and (b) the straightening out of the flexion, neither of which seems to have a rational basis.

The canal which permits the menstrual flow to pass is of ample size to permit the passage of spermatozoa, and therefore it would seem indefensible to dilate it, an argument which applies with equal force to the attempt to undo the flexion. But we know that in cases where there are no other causes for the infertility a fair number become pregnant after this operation, and that is the justification. Dilatation of the cervix in these cases should, however, be undertaken with the greatest care, for sometimes it is impossible to pass even a sound into the uterus owing to the small calibre of the canal and the acute angle of flexion, and perforation of the uterine wall is a grave danger. These patients should be carefully prepared beforehand, by means of vaginal douches and glycerine plugs for several nights; in this way the cervix is softened and the passage of an instrument is both easier and safer. Curettage should only be done when there is a decided indication for

it, and then only lightly, for it is possible to produce a permanent amenorrhœa if performed too vigorously.

Laminaria tents are sometimes recommended for the purpose of dilatation of the cervical canal, and they do succeed very well in thoroughly dilating it; but I am convinced that, however thoroughly prepared, they do occasionally give rise to infection of the endometrium, and this is to be avoided at all costs in dealing with sterility. I have therefore long since abandoned their use in these cases, and rely wholly upon the use of glycerine plugs in the vagina; in this way the cervix is softened and rendered dilatable without the introduction of a foreign body into the uterine cavity.

The employment of a stem pessary. I think most surgeons who have studied the problem of sterility will agree with me when I say that these instruments should never under any circumstances be used when there is any question of infertility. They are introduced at the time of dilatation, and are left in the uterus for any time between 1 and 10 days; they are certain to be responsible for infection of cervix, uterus or tubes, and perhaps all three, and the longer they are left the more certain it is that infection will ensue. The infection is rarely fulminating, but invariably of a low type which is manifested by cervical discharge, a uterus larger than normal, and some added pain at the monthly period. I have used these stems for dysmenorrhœa, but never for sterility, and the results were rarely satisfactory, for the flexion invariably returned, and the subsequent symptoms were suggestive of a condition which could only be explained by a mild infection.

The alternative to the use of a stem pessary for overcoming the acute angle of flexion is dispensing with the cervical canal entirely by incision and suture of the posterior lip, thus making the internal os the os uteri. This is accomplished also by the more elaborate operation of Dudley. These operations upon the cervix for sterility show a complete lack of understanding of the fundamental importance of a healthy and normal cervix in the problem. A healthy cervix not only acts as a sanctuary for the spermatozoa, but it also secretes a medium which is not only favourable to, but probably also attracts them. A cervical canal which is laid open to the internal os must certainly have the microscopical characters and chemical reaction of the vaginal contents which we know are usually inimical to the spermatozoa. These operations frequently result in infection of the incision, leucorrhœa, endocervicitis, and endometritis. Graves asserts that he has had

to perform a tracheloplasty on a number of patients in order to relieve the symptoms caused by the operation. He advocates a modified Gilliam's operation as a means of undoing the flexion of the uterus, and he would lead us to believe that these uteri are soft and flaccid, and as clay in the potter's hands; whereas the flexion is due to the muscular and fibrous tissues which can only be altered in shape or size by physiological causes. Any form of Gilliam's operation will not change the shape of the uterus; the most it can do is to alter its position by moving it as a whole through a small arc of a circle, and any success attending such an operation must be due to whatever backward displacement of the cervix takes place. I do not feel justified in using any of these operations for cases of sterility.

Infections. An infected cervix is a common cause of sterility, and it should be thoroughly investigated before proceeding to the more elaborate measures of inflation and the employment of opaque bodies. The signs of infection are a muco-purulent discharge, swelling and engorgement of the portio, erosions, Naboth's follicles with or without lacerations, and eversion of the cervical endometrium.

The normal cervical secretion is small in amount, transparent, and glistening, with the tenacity of white of egg, and alkaline in reaction. The secretion which normally fills the cervical canal presents the same characters, but it is exceedingly tenacious, and when dislodged comes out in one large drop. It forms a barrier to the invasion of the uterus by organisms which have gained access to the vagina. When the cervix is infected, this secretion becomes opaque in appearance and acid in reaction, and is a suitable medium for the upward spread of infection, but offers an impenetrable barrier to spermatozoa.

The common causes of infection are: excessive coitus, douching, pessaries, late gonorrhoea, lacerations, new growths, and tubercle.

Excessive coitus is responsible for a passive congestion of the pelvic organs, and the cervix reacts with an increased secretion, on account of which the patient comes complaining of the "whites." In appearance the cervix looks somewhat swollen, with some degree of cyanosis. This condition is probably an infection by organisms of low virulence. Regulation of sexual life, together with mild alkaline douches, is usually sufficient to remedy non-specific infections.

Douching. It is a common experience to find that after marriage women make a habit of douching regularly, either with a view to

cleanliness, or more frequently with the object of preventing an early conception. After a time they complain of a vaginal discharge, and when examined the vagina and cervix have the appearance of a sub-acute infection. This infection is produced by strong chemical irritants, the most notorious being lysol and mercury, and the use of a septic nozzle. The common domestic instrument in use for douching is the Higginson syringe, the nozzle of which goes into the rectum or the vagina according to requirement. It may be washed after use, but is never sterilised, and is quite capable of conveying infection from rectum to vagina or vagina to rectum. This type of infection will clear up if the douching is stopped, and pessaries of 1 per cent lactic acid are introduced into the vagina on alternate nights with a douche twice a week.

Foreign bodies. Pessaries for support in prolapse, rubber caps and gold buttons for the prevention of conception, give rise to a chronic infection of the cervix with offensive discharge, despite the utmost care and cleanliness of the patient. No treatment is of any use as long as the foreign bodies are present, but after their removal the condition frequently clears up under mild antiseptic and astringent douches.

Late gonorrhœa as a cause may be impossible to prove by microscopical investigation. It is associated with a thick, yellow, cervical discharge, extensive erosions, follicular cysts, thickening of the Fallopian tubes, and evidence of infection of Bartholin's glands and ducts.

The treatment of cervicitis due to this organism requires much patience and discretion, and frequently fails owing to a limited understanding of the pathology of the condition.

In a few cases, where the infection has not yet gained access to the recesses of the glands, local treatment will show a certain number of successes. In this type of case it is necessary to deal not only with the portio but also with the cervical canal as far as the internal os, taking care not to go beyond it. A Fergusson's speculum should be passed into the vagina, the patient being in the lithotomy position. The cervix is manoeuvred into the centre of the field, the discharge is removed with a dry pad of gauze, and a probe armed with wool and moistened with liquor potassæ or hydrogen peroxide cleanses the cervical canal of all tenacious mucus and discharge. When this is completed, a Playfair's probe covered with wool and moist with iodised phenol, saturated solution of picric acid, or 10 per cent solution of silver nitrate should be passed into the cervical canal and thoroughly rubbed into the surface. Pontampons of glycerine and ichthyol should be used on

alternate nights between the painting, and a douche of 1 per cent lactic acid taken the following morning. This procedure may be carried out once a week for a month, but if no improvement is shown it had better be abandoned, for a deep cauterisation of the cervix must be avoided when the object is child-bearing.

In chronic cervicitis, erosions and follicular cysts are the indications that the compound racemose glands of the cervix are infected, and treatment of the surface by pigments and caustics is consequently of no avail in curing the infection. Strong iodine, iodised phenol, picric acid, and nitrate of silver will change the appearance of an erosion temporarily, but cannot and do not affect the pyogenic processes proceeding in the depth of the tissues. As a means of cure we can dismiss these methods.

There are two methods only for curing the infection : (1) operation, and (2) electro-therapeutic ; (a) ionisation, and (b) diathermy.

The *operations* employed, Schroeder's, Sturmdorf's, and amputation, have the object of excising the infected gland-bearing areas of tissue, and when well performed will result in cure of the disease, but from the standpoint of sterility the operation removes one of the essential factors necessary to the welfare of the spermatozoa. The cervical canal not only affords shelter to spermatozoa, but it also secretes a medium which is favourable to them, and to replace these glands by non-secretory fibrous tissue which takes the chemical reaction of all the vaginal contents must necessarily interfere with the prospect of conception. Leonard reported the results of 128 cases of amputation of the cervix performed at the Johns Hopkins Hospital. Of this number 72 were married women menstruating regularly and below the age of 40 years ; the remainder were over 40 years, and were at or had passed the menopause, or had previously undergone double salpingectomy. Out of these 72 cases, only 14 subsequently became pregnant ≈ 19.4 per cent, although 50 of them were parous women, which means that four-fifths of the women remain sterile after this operation. Therefore as a treatment for sterility there is little to be said for it.

Ionisation in suitable cases is the best therapeutic measure for cases of sterility, but it should never be used where there is any evidence of chronic salpingitis, as it may reawaken the inflammatory process. The patient is placed in the dorsal position with the pelvis well raised, so that the contents of the vagina will not flow out. A medium-sized glass Fergusson's speculum is passed, and the cervix carefully centred. The os uteri is dried and cleansed with small sterile gauze swabs ; similarly the cervical canal is dried and cleansed. A malleable zinc rod,

protected with rubber tubing so that only $1\frac{1}{2}$ inches of metal are exposed at the tip, is now passed into the cervical canal; this is connected with the positive pole of the galvanoset. A solution of sulphate of zinc, 20 grs. to the ounce, is now poured into the speculum until the cervix is covered by it. The negative pole of the galvanoset is a large flannel-covered pad which is soaked in warm saline and applied to the thigh or abdomen. The current is turned on and slowly advanced to 20 milliamperes, reducing the strength immediately if the patient complains of pain. The treatment is continued for fifteen to twenty minutes. By this method ions of zinc are carried into the depths of the tissues. The treatment should be carried out not oftener than twice a week, and persevered with for three or four weeks.

Diathermy is a form of high-frequency current, the purpose of which is to heat the cervix to a temperature of 115° F., a point which is theoretically destructive to gonococci. It seems impossible to construct a thermometer to register the degree of heat being generated in the tissues, and so the urethra is used as an indicator. At 115° F. sensations of heat pass over to the region of pain, and the sensitive urethra registers this impression immediately, but the relatively insensitive cervix would require a much higher degree of heat before a sensation of pain was registered, and cautery effects would be produced. Therefore, the limit of tolerance for the urethra is first found, and from this the strength of current for the cervix is deduced. This mode of treatment should be left to those who have experience of it, for while in skilled hands it has excellent results, it is potentially full of risk, and might easily defeat the object for which it was being used.

Lacerations. It is clear that a laceration without any complication is in no way a barrier to pregnancy, otherwise one or possibly two children would be the rule in family life, for it is almost safe to say that every parous woman has a lacerated cervix. A lacerated cervix becomes of importance where it is associated with infection, or where it is an indication of a previous infection which has spread to the Fallopian tubes and peritoneum; when associated with a cervicitis, the treatment has already been discussed, and the treatment of the latter condition will be described later.

New growths of the cervix, the commonest of which is the stalked submucous myoma. This tumour does not produce sterility by mechanical obstruction, but only owing to the discharge which arises from it. The treatment for this tumour is excision.

Cancer of the cervix does not prevent conception until the tumour has broken down into an ulcer, giving rise to an offensive discharge which destroys the spermatozoa, for pregnancy with an early carcinoma of the cervix is not so very uncommon. This applies equally to other forms of ulceration of the cervix, such as tubercle, syphilis, etc.

MALPOSITION OF UTERUS

Treatment of retroversion. In cases in which all other causes of the sterility have been excluded, what is to be advised in order to maintain the womb in a correct position—pessaries or operation ?

Pessary treatment is worth a trial for a definite period of time ; in my practice it is six months. The objection to the use of pessaries is that they invariably set up a vaginal discharge, despite the utmost care in cleanliness and douching, and they frequently produce ulceration of the vaginal wall through pressure. The only form of pessary for retroversion is the Hodge type, which is made of vulcanite, without india-rubber of any kind, for it is almost impossible to sterilise rubber without boiling it to destruction. This pessary should not be placed in the vagina and left there for two months until it is time to remove and clean it, but should only be worn for a few days at a time. My own practice is to replace the uterus and introduce the pessary two days after the period is over. It remains there for ten days, during which normal marital life is observed, and at the end of that time I remove the pessary until after the next period. After six periods I advise the patients to undergo operation, but where they are strongly averse to it I persevere for another six months, and at the end of that time I abandon it. Ring pessaries have no place in the treatment of retroversion. It is important to emphasise that the uterus must be replaced before the introduction of a pessary, otherwise the pessary becomes a certain liability and not a doubtful asset.

Operation. This method of treatment is curative so far as the position of the uterus is concerned, and it has the advantage that at the time of operation the tubes and ovaries can be inspected and any defects dealt with where possible ; but it may not relieve the sterility, and it is only right to explain this to the patient before obtaining her consent. Many women would submit to an abdominal operation in order to become pregnant, whereas the majority would decline it as a means of

restoring the womb to a position which may or may not be the patient's normal. The operations advised are :

- (1) Shortening of the round ligaments.
- (2) Hysteropexy.
- (3) Uterine fixation.

Gilliam's operation, or some modification of it, is the ideal way of restoring the uterus to a forward position, for it produces the least possible disturbance of the pelvic contents. The uterus is slung and not fixed, and is free to enlarge normally under the stimulus of pregnancy. Giles says that "this method has the great disadvantage of anchoring the fundus low down on the abdominal wall." I disagree with him entirely, for when the operation is not overdone, there is sufficient length of round ligament left between the cornua and the abdominal wall to undergo the growth of pregnancy, and the uterus rises normally into the abdomen. The drawback to this operation is that the round ligaments are frequently so attenuated and frail that the operation cannot be undertaken, in which case we have to fall back upon hysteropexy.

Hysteropexy, as distinct from the older and now abandoned operation of fixation of the body of uterus, is in most respects a satisfactory operation, and Giles considers it the best operation to perform in the circumstances. Nevertheless, it has fixation of the uterus as its object, although, of course, it is carried out low down on the anterior uterine wall, and that part of the uterine wall is necessarily cramped during the growth of pregnancy. However, in eighty cases of pregnancy following operation, Giles reports uncomplicated pregnancy and labour. Apart from pregnancy, however, there is no doubt that this operation does embarrass the bladder, for it limits the direction in which the viscus expands as it becomes distended, and this is no small inconvenience to tolerate.

Uterine fixation is now abandoned for the child-bearing age owing to the interference with the proper expansion of the uterus during pregnancy, thus causing difficult labour, and owing to the reports of cases which have resulted in intestinal obstruction.

The treatment of fixed retroversion. While fixed retroversion is almost certainly an indication of an old pelvic peritonitis, it does not always happen that the tubes are sealed and the ovaries buried, and while treatment for this condition has to be undertaken generally for

dyspareunia or dysmenorrhœa, the question of a secondary sterility not infrequently arises. In the less severe cases palliative treatment may succeed in restoring the uterus to a forward position, and in one of my cases pregnancy ensued, but in this case the tubes were not sealed, hence the non-operative treatment. She was treated by thorough hot douching, glycerine tampons, and the mechanical massage of the mercury bag over a period of three months, at the end of which time the uterus was well forward. Two months later she conceived and was subsequently delivered of a full-time child.

Operative treatment for these cases, unless imperatively required for dyspareunia, dysmenorrhœa, or pelvic pain, should never be undertaken for sterility alone until a hystero-gram has been taken; and where the lipiodol is seen to fill the uterus but none is shown in the tubes, then from the point of view of sterility there can be no justification for opening the abdomen; but where the tubes are filled up to the fimbriæ, there is some chance of a salpingostomy relieving the condition.

Prolapse. In those cases in which it is shown that the prolapse is responsible for the sterility, the question of pessary or operation will have to be decided. A pessary will frequently suffice to support the uterus and keep the patient comfortable, and in a few cases conception may follow, but if it does not follow soon it is not likely to happen at all. Pessaries give rise to a disagreeable discharge which tends to become worse. This discharge is due to changes in the vaginal wall and the cervix, and while it is present there is no hope of pregnancy. These pessaries are only changed once in six to eight weeks, and despite the utmost care and cleanliness on the part of the woman, they are revolting to the eye and nose. In any question of sterility, therefore, an operation is the best treatment. The type of operation is most important, and it must be remembered that prolapse of itself can be efficiently relieved by a vaginal operation, and that no abdominal operation alone will cure the condition. Where the tubes have been proved patent, a vaginal operation is all that is required, but the greatest care is necessary to see that the entrance to the vagina is not unduly narrowed.

In cases in which the tubes are closed to air, and lipiodol shows them to be occluded at the cornua, a vaginal operation may be undertaken for the comfort of the patient, but not on account of sterility. Where the hystero-gram shows the tubes patent as far as the fimbriæ, then a combined operation should be performed. It will be both justifiable and

advisable first to restore the floor of the pelvis, then to open the abdomen, shorten the round ligament, perform salpingostomy and conduct an examination of the ovaries.

INFECTIONS OF THE UTERUS AND TUBES

(1) *Chronic endometritis*, which is a condition in which the uterus is bulky, and the endometrium thickened, the clinical symptoms being leucorrhœa, severe losses at the periods, and continuous backache, is one which is frequently present in patients complaining of sterility. In these cases the sterility is due to two causes: the discharge which is inimical to the spermatozoa, and the unhealthy endometrium which, although conception might take place, offers no favourable focus for the embedding of the ovum. Equally, uterine discharge associated with carcinoma of the body, submucous fibroid, and fibroid polypi are associated with sterility.

Chronic metritis, in which the structure of the endometrium and uterine wall has undergone extensive fibrous-tissue changes, is associated with profuse and long-drawn-out monthly periods. It occurs usually in the fourth decade of life, and is assumed to be the final expression of an earlier infection. Sterility is common, and is probably due to the combined changes in the uterus, tubes and pelvic peritoneum. No treatment for infertility can be of any help to these patients.

The treatment for chronic endometritis is curettage, with the subsequent administration of calcium salts, ergot and pituitrin, until the uterus has assumed a normal size and consistency. These cases are pre-eminently suitable for a course of treatment at Woodhall Spa.

(2) *Infection of the Fallopian tubes, ovaries, and peritoneum*. The commonest causes of salpingitis, oöphoritis, and pelvic peritonitis are gonorrhœa, puerperal sepsis, tuberculosis, appendicitis, and other lesions of the alimentary tract. The mode of origin is of some importance as to whether the infection spends its force upon the tubes or upon the peritoneum. In either case the tubes may be closed, but the only hope for salpingostomy is when the plicæ of the tube are more or less normal. In gonorrhœa and tuberculosis of the tube the stress of infection falls upon the mucous folds, and, where the inflammatory process comes to an end rapidly, it may result in a catarrhal process

where the abdominal ostia are closed but the mucosa has undergone little change. In cases where the infection has been more virulent, however, it may have resulted in complete destruction of the tube with pyo- and hydro-salpinx, etc., together with extensive peritonitis. In puerperal sepsis, after abortion and lesions of the appendix, however, the result is usually shown in extensive pelvic adhesions which may bury the ovaries, occlude the abdominal ostium, and produce distortion of the tubes by adhesions. In these cases the mucosa of the tubes may remain more or less normal in appearance, and, provided the ovaries can be disentangled from the adhesions, a salpingostomy has some chance of success.

The condition of the tubes and pelvic peritoneum is the only indication as to whether any plastic operation is likely to succeed. In cases where the tubes are of normal appearance externally, but the

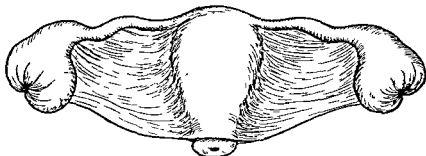


Fig. 1462.—BOTH TUBES ARE CLUBBED AND CLOSED. THE PUCKERED AREA SHOWS WHERE THE INCURVED FIMBRIÆ HAVE ADHERED TOGETHER.

(By permission of H. K. Lewis & Co. Ltd., from "*Sterility in Women*.")

fimbriated extremity is closed and club-like (fig. 1462), and occasionally shows a dimple which is produced at the spot where the incurved fimbriæ have become adherent, a small incision will enable the surgeon to unfold almost normal fimbriæ, which should be conserved and handled delicately, for these are the cases which present the best prospect of success. Where no dimple is seen, a large and efficient salpingostomy results in a certain number of pregnancies, two out of twenty in my own series of cases.

In cases where the tubes are involved in massive adhesions and where the tubes are in a condition of hydro- or pyo-salpinx (fig. 1463), the plicæ are destroyed, the sterility is absolute, and there is no hope of relief from any operation.

We also find instances of highly convoluted tubes, of which figure 1464 gives an impression. These tubes are rarely patent, and they are in all probability instances of arrested development, for there is no

advisable first to restore the floor of the pelvis, then to open the abdomen, shorten the round ligament, perform salpingostomy and conduct an examination of the ovaries.

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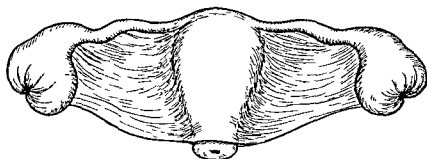


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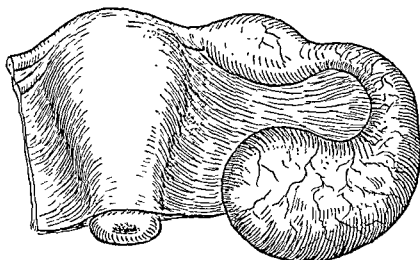
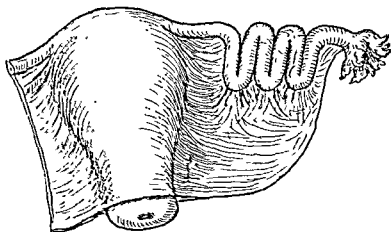


Fig. 1113 — A FALLOPIAN TUBE WHERE THE LINING WALL OF THE TUBE IS DESTROYED. DRAINAGE AND SALPINGOSTOMY ARE OF NO VALUE

(By permission of H. K. Lewis & Co., Ltd., from "Sterility in Women.")

sign of infection of the tube wall or of the peritoneum. The mesosalpinx is condensed and somewhat thickened at the apices of the loops, but section of it at these points does not alter the shape, nor are the tubes patent when freed from this tension.

Treatment. In a case of sterility, when the result of infection of the pelvic peritoneum or viscera, the question of operation, for no other treatment offers any prospect, must and can only be decided by the examination of a hystero-gram. In cases where the uterus alone is shown, the tubes are not only blocked at the cornua, but are



—CONGENITAL CONstriction OF FALLOPIAN TUBES, WHICH ARE NEVER PATENT. USUALLY ASSOCIATED WITH OTHER EVIDENCE OF INCOMPLETE DEVELOPMENT
 (By permission of H. K. Lewis & Co., Ltd., from "Sterility in Women.")

almost certainly destroyed throughout their length ; and in the cases where the isthmus only shows up as a narrow streak, the ampullæ are probably disorganised.

A shadow of the whole tube with a clubbed fimbriated extremity shows that the tube is patent but that the abdominal ostium is closed. These cases are the only ones which offer any scope for surgery, and even then the outlook is not very good.

Some surgeons recommend laparotomy in order to ascertain the exact conditions of the tubes and pelvic viscera. This procedure was justifiable before inflation and radiography enabled us to diagnose not only the patency or closure of the tube, but also the site of obstruction and the probable condition of the tube. They describe operations upon the pavilion and the isthmus, and claim remarkable results. The operations upon the isthmus include resection and anastomosis, implantation of the cut end of the tube into the uterus, and a sliding of the fimbriated end to anastomose with the cornu of the uterus, the technique depending upon the placing of one or two strands of catgut in the lumen to maintain the patency.

Zorn measured the cornual ends of the Fallopian tubes of eighty-four freshly excised uteri by means of specially calibrated probes, and found that the average diameter of the lumen in normal tubes of women in full sexual activity, of gravid tubes, and of tubes in chronic inflammatory conditions, is 0.8-1.0 mm. This explains the difficulty of passing even the finest probe along the tube into the uterine cavity, and practically precludes the passing of needles armed with gut through the lumen into the uterus. When the isthmus is divided *near the uterus, it is very difficult to find the lumen in a healthy tube* ; but where it is the site of stenosis or complete obstruction, as a result of inflammatory products, false passages are certainly made which will surely close despite the presence of catgut. I have performed ten operations of this nature, comprising excision of part of the isthmus with anastomosis of the two ends, implantation of the ampullary end into the uterine wall, and a sliding of the pavilion to the cornual extremity ; before closing the abdomen, inflation of the tubes was attempted, but even at a pressure of 300 mm. Hg. no air passed the junction, and in some of them it escaped at the site of anastomosis. Furthermore, an attempt at inflation three weeks later before the patient went home was also negative ; and I have come to the conclusion that operations upon this part of the tube offer no prospect of relieving sterility.

Operations upon the ampullary end are a little more hopeful, but even in these cases we are not sure to what extent the inflammatory

process which closed the tube has affected the plicæ, and although the lumen may be re-established, the changes may be sufficient to prevent the progress of the ovum towards the uterus, which is shown by reported cases of extra-uterine pregnancy ensuing after salpingostomy. In many cases, however, the newly made opening is found to be closed within a few weeks of the operation, which is possibly due to faulty technique or to starting up the inflammatory process anew. The most favourable cases are those where the fimbriæ are infolded by the adhesions but remain in a condition to be conserved; here the trauma is minimal, and no raw area is left to form adhesions. In cases where an incision is necessary into the club-like extremity and the edges are overstitched, the omentum frequently makes its way to the area and effectively covers in the new opening. When the salpingostomy is done, it is essential that the ovary be freed and lightly fixed near the new opening; in this way any new adhesions will be limited. Out of twenty cases of operations upon the closed fimbriated extremity, eleven were found to be closed again within three months. Two more were found closed at the end of nine months, during which time there was a history of pelvic infection. Five remained patent but no pregnancy ensued, and two became pregnant and bore living children.

T. Tuffier reported a number of cases in which the tubes were destroyed, where he implanted the ovary into the uterus through an incision in the region of the cornu. In the majority of cases the ovary merely sloughed owing to the strangulation of the arterial pedicle which supplied it, and although the menstrual periods reappeared after two to six months, no instance of pregnancy occurred.

In mild cases of pelvic peritonitis the abdominal ostium may remain open, but the ovaries may be shut off from the tubes by adhesions. Provided the ovaries have not undergone grave changes, and can be freed and suspended without any trauma, they offer a reasonable prospect of pregnancy. I have had three successful cases of this nature, the last one being of considerable interest.

A uniparous woman, aged 28, child 6 years old, had a mild attack of pelvic peritonitis, cause unknown, from which she apparently recovered. She went for a change to recruit her health, and while at the sea her periods came on rather unexpectedly and continued for fourteen days, at the end of which time the surgeon advised a curettage, which was done. She was then informed that she had a retroverted uterus, for which a Gilliam's operation was suggested. This more than alarmed her, and on her return she was referred to me for advice. On examination her uterus was straight up, and in the pouch of Douglas there was a cystic tumour the size of a seedless orange. The following week I opened the abdomen and found a few recent adhesions, together with some organised adhesions completely obscuring the right ovary. The elastic tumour in the pouch of Douglas was a cyst of the left ovary, in

which no trace of normal ovarian tissue remained. The cyst was excised and adhesions separated, including a long band from the great omentum to the back of the uterus. The right ovary was freed with great care and slung up on the side-wall of the pelvis. Four months later she became pregnant, an event she had been hoping for during four years. Inflation of the tubes was carried out when the abdomen was open, and both tubes were demonstrated to be patent.

In another case, associated with appendicitis, the patient had been watched through an acute attack, and at the end of three weeks she was still being watched, though obviously ill. The friends demanded a consultation, and I saw the patient with an abscess rising as high as the umbilicus. Two hours later I drained the abscess, but postponed dealing with the appendix, as it was not easily found. The abscess was a huge cavity extending down into the pelvis and upwards to the region of the navel. She made a fair recovery, and remained well for nearly a year, when she had a sub-acute attack of appendicitis, and I urged immediate operation, which was accepted. She was about to be married, and in view of her history she asked me to determine whether she would be able to have children. I passed the uterine tube before opening the abdomen and inflated her when the peritoneum was open; both tubes were patent, but both ovaries were shut off from the peritoneal cavity by well-formed veils of peritoneum. They were both freed with great care, and slung up by a stitch to the side-wall of the pelvis. She married and became pregnant within a year.

Therefore, when the tubes are patent and other causes have been excluded, opening the abdomen to inspect the ovaries is not only justified, but it frequently repays the patient for the risk and inconvenience she suffers. On the other hand, the utmost care and delicacy of handling must be employed, or the patient's condition may easily be made worse.

Tumours of the uterus. Carcinoma of the body of the uterus rarely plays a part in the question of sterility, for it occurs generally at an age when the child-bearing period of life is over, and therefore requires no consideration.

Fibroids of the uterus are of some interest, however, for sterility is so commonly associated with them, and it has been asserted that the growth of fibroids is an expression of lowered fertility. This statement, however, can only be a partial truth, and strictly limited to those cases where the fibroid so changes the endometrium as to be inimical to the spermatozoa or to the ovum for embedding. We frequently see patients with a fibroid who have conceived, and our advice is usually sought for the effect that the tumour will have upon labour; fibroid tumours *per se* have no relation to sterility.

I may say that a subperitoneal fibroid does not influence the question of sterility, though it frequently does that of labour. The interstitial type of fibroid, unless it has encroached upon the cavity of the uterus and has

induced endometrial changes, has also no bearing upon conception, but it may result in miscarriage; whereas the submucous fibroid and the stalked fibroid have associated changes in the endometrium which give rise to a discharge, and are thus the direct cause of sterility. On the other hand, uteri which are studded with small fibroids are associated with sterility, not owing to the presence of these tumours, but owing to the fact that the structure of the whole uterus is abnormal and these growths are merely the expression of that change.

The large cervical fibroid has a direct influence upon conception in so far as it is responsible for changes in the cervical canal, and thus offers an additional barrier to the passage of spermatozoa.

The treatment of fibroids in relation to sterility. From the point of view of sterility there is clearly only one mode of treatment, and that is by myomectomy, and in a certain percentage of cases this operation is followed by pregnancy.

The subperitoneal fibroid may require excision for various good reasons, but unless it is of such a size as to cause some obstructive change in the uterus or tubes, its removal will not relieve the sterility, and this view must be clearly explained to the patient before undertaking the operation.

The interstitial and submucous fibroids should be enucleated, and in cases where a relatively healthy uterus is left after the operation, the prospect of a pregnancy ensuing is sufficiently good to justify it. However, in many cases the fibroids are numerous, and the aggregate tissue removed is vastly greater than the uterine tissue left behind; indeed the uterus, when stitched up at the end of the operation, has no resemblance to a uterus at all, and there is grave doubt whether it is worth while or advisable to leave it.

In one case where I had removed fifteen fibroids of varied size, the uterus as left was a shapeless mass the size of a small plum, and I was in grave doubt as to leaving it. However, a year later I had to open the abdomen again and I was agreeably surprised to find that I could identify the organ not only by its site and relations, but also by its size and appearance. This patient subsequently became pregnant, and was delivered at term of a living child two years after the myomectomy. Two other cases of mine also became pregnant after removal of one large fibroid and four medium ones respectively.

When enucleating fibroids for sterility, it is important to examine and inflate the tubes, for there is frequently an associated salpingitis which is the source of the sterility. The ovaries are also commonly in the condition known as "cystic ovaries," and require resection if the patient is to be given the best chance of conception.

Sterility due to ovarian deficiency. We know that before puberty and after the menopause ovarian activities are suspended or abolished, and in consequence child-bearing does not occur. Similarly, if for any reason during the child-bearing period of life ovulation is prevented, sterility ensues. It is unfortunate that, except in cases of complete suspension of function of the ovaries, we have no means of determining their value for child-bearing save by operation. We can detect tumours and cysts of the ovary, and determine the presence of inflammatory products in the pelvis; but whether ovarian tissue is available for ovulation, and if so how much, can only be decided by inspection of the organs. Therefore it follows that where the semen is properly deposited in a healthy vagina, and the uterus and tubes are apparently sound and patent, the question of laparotomy to examine the ovaries will arise.

The conditions which we may expect to find are :

(1) Inflammatory results ; (2) tumours or cysts ; (3) the presence of corpora lutea.

Inflammatory results have already been discussed in cases of pelvic peritonitis where the ovaries were shut off from the peritoneal cavity by adhesions, and the cases in which they were destroyed by tubo-ovarian abscess need no examination from the viewpoint of sterility.

The cystic ovary is a common condition, and almost certainly the result of inflammatory changes. The ovary is enlarged with a thickened tunica albuginea, and when palpated is found to be packed with small cysts. These small cysts are Graafian follicles which have failed to rupture owing to the strength of the much thickened albuginea. Resection of the cyst-bearing area is the only possible treatment, leaving as much normal ovarian tissue as can be seen. It has also been suggested that the albuginea should be incised and the ovary decapsulated. The former operation I have done with no success, while the latter does not appear to me to offer any other prospect than formation of adhesions to the nearest structure.

Tumours or Cysts. All simple cysts should be excised, leaving the unaffected portion of the ovary. The presence of small ovarian cysts may have a restrictive action upon a normal ovary of the other side.

I have now operated upon six cases of small ovarian cysts in one ovary, the other being normal, in parous women who had remained sterile for periods of 3, 5, 5, 6, 7, 7 years respectively after the birth of the last child. On the affected side there was little or no ovarian tissue left in four of them, and in the other two only a small part of the ovary remained. The ovary on the opposite side was normal in each case. Four of

these women became pregnant within three months of the operation, and the other two remained as before.

In another case, which shows the importance of leaving the smallest bit of ovarian tissue where possible, the patient was a nulliparous woman, aged 35 years, who had had the right tube and ovary removed in the course of dealing with a suppurating appendix. She had no children, and consulted me for sterility, when I found a cyst the size of a tangerine orange in the left ovary. I advised her that she would remain childless unless the cyst could be removed, leaving sufficient normal ovarian tissue for ovulation, and at the same time warned her that though the operation might succeed, she would probably remain childless. However, she elected to undergo the operation, and when the abdomen was opened the left ovary seemed to be represented by this cyst, but it had a rim of tissue around it. In ordinary circumstances I should have excised the ovary, but in this case I excised most of the cyst wall only, destroyed the lining with pure carbolic acid, and stitched the cut edges of the cyst wall together. Six months later that patient became pregnant.

Bilateral cysts of the ovaries are almost certainly associated with sterility, whether there be ovum-bearing ovarian tissue left or not. This is owing to the pressure and distortion produced by the cyst, whereby the ova rarely ripen, and if they do the prospect of their gaining entrance to the Fallopian tube is poor. Exceptional cases occur where pregnancy has ensued, despite the presence of bilateral cysts. I have had one case of pregnancy after removal of a cyst from each ovary. Growths which destroy the ovaries are naturally productive of absolute sterility.

The influence of persistent corpora lutea on amenorrhœa and sterility.
The persistence of a corpus luteum in cattle is said to be responsible for 70 per cent of the sterilities which are known to be fairly common in herds of pure breed. Veterinary surgeons have observed that if a false corpus luteum remains unabsorbed in either ovary of a cow she does not come on heat nor does she conceive. Apparently the ovaries in these animals can be easily felt and compressed through the rectum, and in cases where they do not come on heat the corpus luteum is expressed manually through the rectal wall, after which the animal comes on heat within two to five days, and under favourable conditions becomes pregnant. The true corpus luteum is retained in the cow for thirty to seventy days after parturition, a statement which is based upon: (1) the absence of heat for this period after calving; (2) true corpus luteum can be felt for this length of time by the veterinary surgeon; (3) when this corpus luteum is expressed, heat comes on within two to five days. A further interesting fact is that the corpus luteum remains unabsorbed during lactation, and that cows and mares allowed to run with their offspring do not come on heat for a much longer time than is usual when weaning takes place early.

Ochsner states that expression or excision of the false corpus luteum in the human female is followed by menstruation in twelve to thirty-six hours, and he gives the details of nine cases. He concludes that unabsorbed false corpora lutea prevent ovulation, and that they are a common cause of sterility.

If the statements made about corpora lutea in cattle are accurate, then Ochsner with his experience in women is justified in coming to the conclusion expressed. I have had no experience of excising corpora lutea, and therefore am not in a position to criticise it; but if it be so, it offers a further reason for opening the abdomen in cases of sterility where the man is sound and no adequate reason for it is found in the woman.

Artificial Insemination. The cases in which this procedure is called for must be exceedingly rare, for in a fairly large experience I have only met one case in which it seemed to offer any better prospect than that

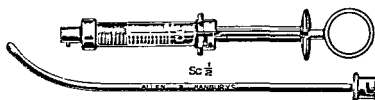


Fig. 1465.—SYRINGE WITH LONG NOZZLE FOR ARTIFICIAL INSEMINATION.

of remaining childless. It was in the case of a highly apprehensive man who appeared to have what might be described as a "lightning erection"; the penis no sooner became erect than ejaculation took place, so that coitus was never effected. The semen contained normal-looking spermatozoa, but deturgescence took place so rapidly that penetration never occurred. Injection into the uterus of the semen caught in a rubber sheath on six occasions brought no success, and the procedure was abandoned. Successful instances have been recorded by John Hunter, Marion Sims, and others, but so far as my inquiries go no one has made any claim equal to that of Bethel Solomons, who reports six successes out of seventeen cases.

The technique is simple, the instruments required being a special syringe with a long nozzle, of circumference not larger than a uterine sound, a Sims speculum, and a tenaculum. A recently ejaculated specimen of semen in a rubber sheath maintained at body temperature must be available. The woman should be placed in the lithotomy position, the speculum passed, and the cervix fixed with a tenaculum. The vagina and cervix are cleansed with dry mops, and the nozzle of

the syringe filled with semen is carefully passed through the os and into the uterus without being allowed to touch the vaginal walls. It is slowly injected, and the syringe withdrawn, the patient being kept in bed for the day. The time at which this experiment is conducted should be carefully chosen to follow the monthly period from the third to the tenth day, for this is the time most favourable to conception. The cases in which this method is suitable are those in which it is a physical impossibility for the semen to be deposited in the vagina, for instance, hypospadias, urethral fistula, and lack of virility as in the case quoted. Cases are recorded in which semen deposited in the vagina during coitus was drawn up into a syringe and injected into the uterus. This method of course is fraught with grave risk of introducing any or all the organisms which infest the vagina into the uterus, thereby setting up an endometritis; moreover, the spermatozoa may all have been killed during their short stay in that inhospitable viscus.

SECTION 4

TUMOURS OF THE OVARY

by

V. B. GREEN-ARMYTAGE

THE ovary possesses cells which are at the very origin of things, old as the human race, cells that are totipotent, capable of reproducing every other kind of cell found in the body. When such cells take on vicarious growth we have a potentiality for variety that is unequalled elsewhere, and yet it will be shown that the numerous functionless embryonic rests in the human adult ovary are all derived from germinal cells and retain a great deal of the reproductive properties of their parent.

It is in this fact that we find an explanation of the great diversity of new growths in the ovary, and it is from this also that the great difficulty arises in determining a classification that comprises all tumours. These are the words of Goodall, of Montreal, who, in 1920, simplified our conception of the origin of ovarian neoplasms by describing an epithelial tubular system in the embryonic ovary which runs from the germinal epithelium on the surface of the cortex through the ovary and into the mesosalpinx, where it joins up with the Wolffian duct.

He contends that this tubular system is of oöphoronic origin and capable of producing egg cells throughout its course from the cortex to the hilum, and that from it are derived the Graafian follicles. After the formation of such follicles as are needed the remainder of the tubules disappear by atrophy or absorption, but portions of such may continue as relics. It is from these remnants that epithelial new growths of the ovary arise.

The tubules found in the hilum of the ovary and originally called Wolffian are, according to Goodall, relics of the rete ovarii.

Such embryonic ovarian rests may remain dormant for all time, but, on the other hand, may be awakened into activity at any stage of a woman's life from infancy to senescence. The cause of such

awakening is not known, but it is probably connected with the thyroid, adrenal, and anterior pituitary glands principally, for the ovary is an organ whose nerve and blood supply is in a constant state of flux. Goodall contends that at a certain age of embryonic life (the asexual age) the sex organ is indistinguishable as to sex, and that numerous

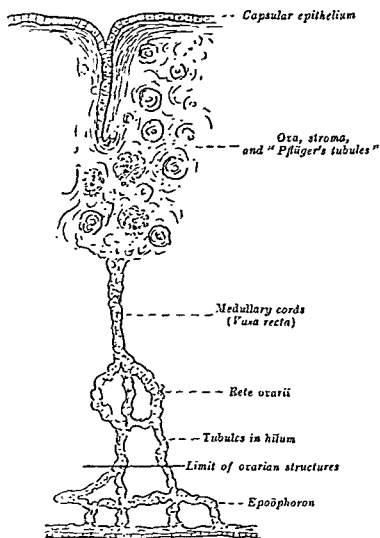


Fig. 146a.—DIAGRAM SHOWING THE TUBULAR RELICS IN THE OVARY, WITH AN INDICATION OF THE MASCULINE HOMOLOGUES.

(With acknowledgement to W. H. B. and M. D. D.,
"American Journal of Cancer," Vol. xvi, 1912.)

sex cells develop at the site of the gonads. Into this cell mass the germinal cells extend in solid columns (Pflüger's columns) and reach the centre of the ovary where they converge into a mass of cells, the rete ovarii, from which further columns of germinal cells extend downwards to the hilum of the ovary to connect with the Wolffian body in the broad ligament (see fig. 146b).

In the male type the solid columns of cells become tubular and form a continuous efferent channel from the germinal layer to the Wolffian body. If, however, the fœtus develops into the higher female species the continuity of the male channels is lost, and many remain as solid cords, being represented as Pflüger's ovisacs, medullary rays, rete ovarii, Kobelt's tubes, and Gartner's ducts respectively.

From this it will be understood that any or every ovary may contain remnants of the male canals in its structure which all belong to the germinal epithelium. These germinal cells are totipotent, capable of developing tumours varying in complexity from an endothelioma to a teratoma, and possessing powers for metaplasia that are unequalled.

Such a theory based on embryology is simple and worthy of entertainment for it explains the formation of epithelial, mesothelial, and hypothelial tumours of the ovary, but unfortunately has not yet been confirmed.

Wilfred Shaw, after much research, has strongly contested the conclusions of Goodall, and is of the opinion that the downgrowths from the germinal epithelium during the first three months of foetal life are solid masses of cells which never assume the form of tubules, and are entirely separated from the rete ovarii and Wolffian body by mesenchymal connective tissue. These medullary cords consist of cells similar to those of the germinal epithelium together with primordial ova, which never form Graafian follicles. He contends that *during the third to the fifth month of foetal life a fresh system of sex cells begins to be differentiated, and that it is from this system that the primordial follicles arise.* These sex cells originate mainly from fresh downgrowths of the germinal epithelium. He is not willing to accept the somewhat unscientific view that embryonic rests of the medullary cords are found in the adult ovary, or that they are ever tubular and the source of epithelial neoplasms. He is of the opinion that all such neoplasms are primarily derived from germinal epithelium, and that since it has been abundantly shown that cysts of the cortex of the ovary can arise from downgrowths of the surface epithelium, so it may be assumed that the property of invagination from the surface in the adult ovary is inherited from the same property in the embryo.

The problem is one of peculiar difficulty, for the findings of Shaw hypothecate the metaplasia of coelomic endothelium which is cuboidal into the columnar epithelium found in all gland-like neoplasms. That such metaplasia does occur throughout the Müllerian tract, we have long known; it is therefore possible that under certain conditions of

endocrine dysfunction, the deeper layers of the granulosa cells of the follicle may develop into columnar epithelium with basal nuclei and so be the origin of cystadenomata and other epithelial tumours. Such explanation is not fantastic when we remember that the granulosa cells of the follicle and the lining cells of the Müllerian cord both have their origin from invaginations by the mesothelial cells of the splanchnopleure; for if the cells of the Müllerian cord after canalisation can undergo the various forms of metaplasia that constitute the mucous membranes of the genital tract, there would seem little reason why the granulosa cells of the follicle should not undergo equally revolutionary changes under the influence of metabolic or endocrinal dysfunction.

The ovary is so complex an organ and so constantly in a state of physiological flux that it is possible an explanation of its epithelial neoplasms lies in and between these two theories. It has, therefore, been thought best to adopt a classification based upon that of Meyer and Goodall.

<i>Origin.</i>	<i>Pathology.</i>
Graafian Follicles.	<div><div>(1) Hydrops folliculi.</div><div>(2) Corpus luteum cysts.<div>(1) Single.</div><div>(2) Compound.</div></div><div>(3) Theca-lutein blood cysts.</div><div>(4) Granulosa cell tumours.</div></div>
Ova	<div><div>(1) Innocent.<div>(a) Dermoid cyst.</div><div>(b) Thyroma.</div></div><div>(2) Malignant.<div>(a) Teratoma.</div></div></div>
Germinal Epithelial or Embryonic Rests	<div><div><div>Serous</div><div><div>(1) Innocent.<div>(a) Simple serous cystoma.</div><div>(b) Papillary serous cystadenoma.</div><div>(c) Psammoma.</div></div><div>(2) Malignant.<div>(a) Papillary cystadenoma.</div><div>(b) Adeno-carcinoma.</div></div></div></div></div>
	<div><div><div>Pseudo-mucinous</div><div><div>(1) Innocent.<div>(a) Simple cystadenoma.</div><div>(b) Papillary cystadenoma.</div></div><div>(2) Malignant.<div>(a) Papillary cystadenoma.</div><div>(b) Secondary malignant degeneration.</div></div></div></div></div>
	<div><div><div>Solid</div><div><div>(a) Simple adenoma.</div><div>(b) Adeno-carcinoma.</div><div>(c) Ovo testis.</div></div></div></div>

<i>Origin.</i>	<i>Pathology.</i>
Connective-tissue Cells	{ (1) Innocent. (a) Fibroma : Fibromyoma. (b) Chondroma : Angioma. (2) Malignant. (a) Sarcoma. (b) Endothelioma.
Extrinsic Origin	{ (1) Endometrioma. (2) Hypernephroma.
Metastatic Origin from	{ (1) Mammary carcinoma. (2) Gastro-intestinal carcinoma. (a) Krukenberg type from stomach. (b) From bowel. (c) From the uterus. (d) Carcinoma elsewhere.

HYDROPS FOLLICULI

This cyst rarely exceeds the size of a tangerine orange and most often is found quite unexpectedly in the course of pelvic operations. As a rule it gives rise to no symptoms. It is single, thin-walled, and translucent, lined by one layer of cuboidal cells which are never ciliated. The fluid contents are albuminous.

A follicular cyst may occur and recur at any time during the menstrual life of a woman, and tends to rupture spontaneously ; for this reason it is frequently the cause of dissension and differences of opinion between doctors. At times during vaginal examinations the capsule of one of these tumours may be felt to burst and a few hours later there may be colicky pains in one or other iliac fossa simulating and (regrettably) often mistaken for appendicular colic.

In my opinion these cysts are not inflammatory in origin. Their pathology is quite different from the small multiple bilateral translucent cysts so frequently met with in women who give a history of pelvic inflammation or abortion, with menstrual disturbances at a later date.

The follicular cyst can always be enucleated without sacrificing the main substance of the ovary, whereas the multiple small cysts associated with old inflammatory trouble cannot be enucleated and call for hemisection of one or both ovaries as a rule.

CORPUS LUTEUM CYSTS

Such tumours are not of common occurrence, nor perhaps should we expect them to be, seeing that the life of the corpus luteum, except

during pregnancy, is a brief one. But, from time to time, a surgeon may meet with such a cyst which has lutein cells in its wall which may or may not be visible to the naked eye. Most often the cysts are found in women who have had a pregnancy interrupted or have been the subjects of hydatidiform mole.

In the tropics vesicular mole for some unknown reason is peculiarly frequent, and has a disturbing mortality from sepsis and hæmorrhage. It is, therefore, my custom to treat all such cases (seen early) by hysterotomy. In 61 per cent bilateral theca-lutein bubble-like cysts have been found with clear contents, boiling solid with albumen.

The commonest type of corpus luteum tumour is, undoubtedly, the tarry or chocolate cyst which is so frequently found at operation in both ovaries. These tumours probably originate from congestion and proliferation of the granulosa cells of the theca interna, with consequent rupture of minute blood-vessels and gradual distension of the corpus luteum, for the blood is either laminated or semi-clotted and tarry. On section, lutein cells can be seen in the walls. Occasionally, if the distension of the cyst is too abrupt, the blood may escape and give rise to severe symptoms of intra-pelvic hæmorrhage, but more often the signs and symptoms are those of sub-acute and transient pelvic distress.

Such chocolate cysts of the corpus luteum probably owe their origin to pituitary-ovarian dysfunction, and as a consequence are frequently bilateral, giving rise to symptoms of pelvic pain, dyspareunia, and menorrhagia demanding surgical interference.

Clinically, the condition may very closely resemble that of chronic tubo-ovarian disease of inflammatory origin in that these patients are often nulliparæ, or it may be that many years have elapsed since the last childbirth, but, if there is no history of abortion or infection and the semi-cystic masses are not peculiarly sensitive, fever is absent, and a white blood count is normal, a tentative diagnosis may be made with some assurance.

In tropical countries the condition is very common.

It is important to realise that these lutein tarry cysts, small, multiple, bilateral, and frequently adherent to the pelvic wall or uterus, are different from the large bilateral endometrial chocolate perforating-cysts of Sampson (see page 2651), for the corpus luteum tarry cyst develops from the membrana granulosa, and its cells can always be demonstrated, whereas the endometriomatous chocolate cyst of the ovary, single or bilateral, originates by metaplasia or implantation and shows its endometrial structure under the microscope (see figs.

1478 and 1479). Moreover, the surgical treatment is different; in the one hemisection or excision is sufficient, whereas in the other complete extirpation, with or without hysterectomy, may be indicated.

GRANULOSA CELL TUMOURS

These rare neoplasms whose elements morphologically simulate the lining membrane of the Graafian follicle are of much interest and importance in that, although most commonly met with during the

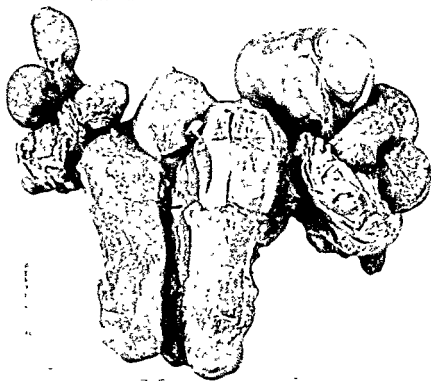


Fig. 1467.—MALIGNANT BILATERAL GRANULOSA CELL TUMOURS OF OVARY.
THIS PATIENT DIED 8 MONTHS AFTER OPERATION.

active sex life of a woman, they may originate in early youth, giving rise to symptoms of precocious puberty; on the other hand, they may arise after the menopause, causing hæmorrhage and hyperplasia of the uterus and its mucous membrane.

These features are due to the fact that the essential cells of the tumour secrete œstrin, and are probably dependent upon the anterior pituitary gland.

My experience embraces five cases only; one was seen before puberty, two were post-menopausal, and two occurred during active sex life. Two only showed bilateral tumour formation, and one of

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GRANULOSA CELL TUMOURS

These rare neoplasms whose elements morphologically simulate the lining membrane of the Graafian follicle are of much interest and importance in that, although most commonly met with during the

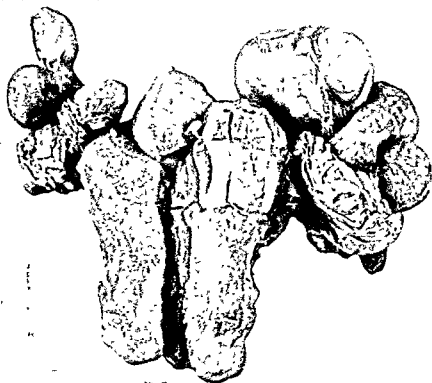


Fig. 1467.—MALIGNANT BILATERAL GRANULOSA CELL TUMOURS OF OVARY.
THIS PATIENT DIED 8 MONTHS AFTER OPERATION.

active sex life of a woman, they may originate in early youth, giving rise to symptoms of precocious puberty; on the other hand, they may arise after the menopause, causing hæmorrhage and hyperplasia of the uterus and its mucous membrane.

These features are due to the fact that the essential cells of the tumour secrete œstrin, and are probably dependent upon the anterior pituitary gland.

My experience embraces five cases only; one was seen before puberty, two were post-menopausal, and two occurred during active sex life. Two only showed bilateral tumour formation, and one of

these died eight months after hysterectomy from metastases in the liver and spleen. They are more often benign than malignant, and clinically present the picture of semi-solid irregular tumours, rarely larger than a tangerine orange, with a greyish-pink surface. Adhesion to neighbouring structures was not a feature in my cases. Microscopically, a mass of granulosa cells can be seen in irregular islands which are defined by thin strands of vascular connective tissue. The cells often appear to be grouped around empty spaces which mimic the ovum. The nuclei of the cells stain well and appear spindle-shaped.



Fig. 1468.—SECTION OF GRANULOSA CELL TUMOUR (SECTION OF MALIGNANT TUMOUR
SEEN IN FIG. 1467).

Malignancy is difficult to be sure of unless the growth has invaded the uterus or surrounding structures. Clinically, pre-puberty or post-menopausal uterine hæmorrhage in the presence of a tumour felt per rectum or per vaginam should suggest a granulosa cell tumour and confirmation be obtained by a prolan A urine reaction.

The treatment is surgical. In a girl or young woman, when possible, the uterus and ovary should be conserved, but, after the menopause, complete hysterectomy with removal of both ovaries is the ideal treatment.

DERMOIDS

These cysts, which should really be called teratomata because they contain all three embryonic layers, may be met with at any age from infancy to senescence. They grow slowly, and unless they inflame, impact, twist, or are influenced by the occurrence of pregnancy, rarely give rise to notable symptoms. They may be multiple in the same ovary or be found in the wall of a pseudo-mucinous cyst. The surface is smooth and glistening, and the yellow contents can often be seen through the thin cyst wall. Hair is invariably found either free or attached to the embryonic node which projects into the cavity of the cyst. This node or teratomatous focus, solid and craggy, may contain sebaceous glands, cartilage, bone, teeth, bronchial mucous membrane, and occasionally thyroid gland structure. The active sweat glands form the source of the fatty contents of the cyst, and quite frequently at operation I have met with sebaceous balls, varying in size from a pea to a walnut, which have filled the cyst cavity.

The ovary can usually be seen on the surface of the cyst, flattened out but discrete. Very occasionally malignant changes can occur in the wall of the tumour. Twice I have met with dermoid cysts which were retroperitoneal; others have been described in the mesentery and utero-vesical septum. Such tumours are probably due to accessory ovarian tissue remnants.

SOLID DERMOIDS

These tumours are exceedingly rare and are usually called ovarian teratomata. They grow with great rapidity and may attain a great size. The only one I have met with was in a young married woman of seventeen who, because of the amenorrhœa and rapidity of growth, was thought to be pregnant. When seen, the tumour, nine months after cessation of menstruation, reached the ensiform. There was considerable ascites. X-ray examination demonstrated the nature of the tumour, and after removal, which was not difficult, every type of embryonic tissue was encountered. There were areas of soft brain-like matter interspersed with solid areas containing cartilage and bone. The main mass showed multiform sarcoma cells. Three months later there was evidence of recurrence in the lung and abdomen and she died after a large hæmoptysis.

The origin of this highly malignant tumour is not understood. Parthenogenesis is held to be the cause by some authorities, but it

would seem more probable that totipotential cells of the ovary, possibly from the germinal epithelium, are capable of producing a teratoma as a result of some unknown stimulus from the hypophysis.

THYROMA

Struma ovarii is the name given to certain rare growths which contain iodine as in the case of thyroid tumours. They are teratoid in type, and histologically resemble a colloid goitre, consisting of a series of vesicles lined by low columnar epithelium. They are not necessarily malignant. Cases have been reported where the tumour gave rise to toxic symptoms. I have never met with a pure thyroma, apart from a dermoid.

SEROUS CYSTS

These tumours may be unilocular and labelled cystomata, or may be multilocular, when they are called cystadenomata (fig. 1469). They are thin-walled and may grow to a considerable size; occasionally they are bilateral. The larger they become the more is the substance of the



Fig. 1469.—SMALL SEROUS CYSTADENOMA CUT OPEN TO SHOW DAUGHTER CYSTS IN WALL AND HEALTHY PORTION OF OVARY STILL REMAINING.

ovary replaced, so that eventually no ovarian tissue may be discoverable. Figure 1469 presents a small serous cystadenoma with daughter cysts. Healthy portions of the ovary can still be seen on the right side of the picture.

Personal experience indicates that the serous cyst is the commonest type of ovarian tumour complicating pregnancy, for it has been found by me in sixteen out of twenty-nine such cases.

The contents are clear and highly albuminous. The cyst wall may readily burst on handling. Histologically, whatever their size, they can be differentiated from follicular cysts by one essential feature, namely, that the lining membrane cells are low columnar in type and ciliated; moreover, goblet cells exist. Papillomata are a common feature of these tumours. In some these processes are warty and have a broad base; in others they are flocculent and arborescent, filling the whole cavity.

In still others, as the cystadenoma has grown, invagination or invasion of its wall has occurred, and delicate or warty papillomata



Fig. 1470.—SHOWS WARTY PAPILLARY GROWTH IN ONE OVARY OF A WOMAN OF 55. THE OTHER OVARY IS SCLEROTIC.

appear on the outer surface of the tumour. In some it is not improbable that these extrinsic papillary processes arise from surface epithelium independently of the intra-cystic papillomata, in exactly the same way as do the warty papillary growths which are so frequently seen at operation on the ovaries of old women. Figure 1470 shows one warty ovary in a patient age 55, whereas the other is sclerotic.

These highly vascular structures covered by ciliated columnar epithelium and goblet cells may implant or graft themselves on to the mesentery, omentum, or any viscus of the peritoneal cavity, and by irritation, or perhaps secretion, produce ascites (see fig. 1471). Figure 1471 is a photograph of such a cyst which, full of papillary growths, has burst its capsule. At operation the ascites and secondary growths



Fig. 1671.—PAPILLARY GROWTHS FILLING CYSTIC SPACES AND CAUSING SECONDARY PERITONEAL METASTASES. GERMANY, ASCITES AND FRAGILITY SUGGESTED MALIGNANCY. SECTION SHOWED INNOCENT PAPILLOMATA. PATIENT ALIVE 5 YEARS LATER.

strongly suggested malignancy. But section of the papillary processes showed no such evidence. The patient was alive five years later.

The tumours are often bilateral; but, whereas the papillomatous cystic enlargement of one ovary may be great, in the opposite ovary it may be seen to be just commencing. It is a remarkable fact, long observed, that if the parent tumour or tumours be removed the ascillary secondary deposits and ascites quickly disappear. This phenomenon is, however, not constant nor can it be relied upon for a sure prognosis, for, if on section the stroma-core of the papillæ is thick, oedematous, and infiltrated with leucocytes, or the surface epithelium heaped up and irregular, and is showing rapid multiplication and mitoses, the probabilities of malignancy are very great. Moreover, in such cases it is not infrequent to find the ascitic fluid pink like fish's blood. On three occasions I have known death to occur from secondary deposits in the lung and upper abdomen within a few months of my having removed such tumours from the pelves of women in whom the papillæ showed the above features.

The question has often been asked why *innocent* papillary tumours are bilateral and how intra-cystic papillomata are able to sprout through the wall. Wilfred Shaw has demonstrated that the origin of these serous cysts can be attributed to downgrowths from the surface epithelium of the ovary, and his contention is that the stimulus which initiates the intra-cystic growths can also produce surface ones, for how else can one explain the undoubted fact that such tumours are very

frequently bilateral? Moreover, he is of the opinion that the secondary peritoneal growths that these innocent papillomata form are due to metaplasia and not implantation, in that there is morphological identity between the surface epithelium of the ovary and the mesothelium of the peritoneum.

In view of his work and the serosal theory of endometriosis this conception is worthy of consideration and entertainment.

PSAMMOMATA

These are tumours characterised by possessing calcareous papillomata in their walls. In most specimens calcium salts are limited to the papillomata. Where the papillomata are profuse, the shadow of such deposits may be seen on a radiograph. I have frequently met with psammomatous deposits in the papillæ of serous cystadenomata.

THE PSEUDO-MUCINOUS CYST

This is the commonest of all ovarian tumours and may reach colossal dimensions. It is invariably lobulated and multilocular, its contents varying in consistency and colour, some loculi being full of slimy white material, others of dark greenish ropy fluid. This is

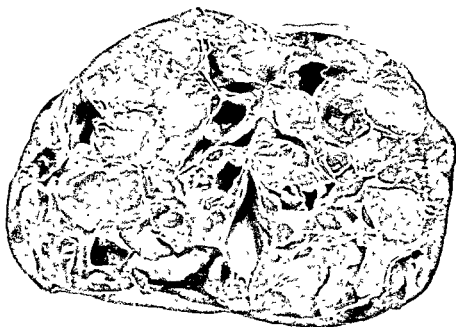


Fig. 1472.—PSEUDO MUCINOUS CYST BISECTED SHOWING CONTENTS AND TRABECULÆ.

pseudo-mucin, a glyco-protein product of the goblet cells. It is alkaline and not precipitated by acetic acid, and contains certain ferments.

In some tumours the lining membrane is smooth, and the cells are columnar and gobletted. In others there are, in addition, warty or cauliflower-like papillomata. Partial or complete trabeculae are constantly found when the tumours are sliced open. Some of the loculi contain brain-like material made up of soft adenomatous tissue which may have the microscopic appearance of malignant degeneration.

It is by no means uncommon to find a dermoid cyst at the periphery of a pseudo-mucinous cyst.

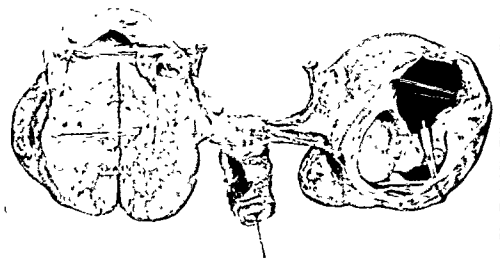


Fig 1473.—BILATERAL PSEUDO-MUCINOUS CYSTS AND UTERUS. THE TUMOUR OF THE RIGHT OVARY WAS FILLED WITH BRAIN LIKE MATERIAL WHICH PROVED TO BE ADENOCARCINOMA. THE PATIENT WAS 38 YEARS OLD. THERE WAS ASCITES. SHE WAS ALIVE 5 YEARS LATER.

Apart from torsion, which is rare, and malignant degeneration with involvement of surrounding structures, a very large personal experience of these mammoth cysts leads me to think that rupture of one of the loculi is the commonest accident met with when the tumour becomes bigger than a full-term pregnancy, for it must be remembered that the rapidity of growth of such tumours is roughly half to three-quarters of an inch per mensem.

The result of such rupture of a loculus may be intense pain and irritative peritonitis with ascites, but more often it spells a curious condition known as *pseudo-myxoma peritonei*, in which the cell lining of the ruptured loculus becomes implanted on the intestine, mesentery, omentum or viscera, and continues to secrete pseudo-mucin, giving rise to a slimy jelly-like secretion which necessitates repeated laparotomy. This condition is quite commonly seen accompanying the

colossal tumours met with in the tropics, but is rarely seen in England. Unlike the innocent secondary outgrowths of the serous papillary cyst-adenoma, this condition is not curable by removal of the parent tumour, for it is impossible to remove completely the conglomerations of scattered secretory cells. I have encountered many pseudo-myxoma peritonei tumours and it is my opinion that they are almost invariably fatal, although in recent years deep X-ray therapy has justified optimism in early cases.

Malignant degeneration in pseudo-mucinous tumours is not so frequently seen in the West as it is in the tropics, for the reason that early diagnosis and operation in Europe make the likelihood of such occurrence less. But, if a tumour suddenly becomes painful and fixed, and there is concomitant ascites with slight fever and marked wasting, the chances are that carcinomatous changes have begun, and that at operation both ovaries will be found to be the site of tumours. I have encountered a very large number of such cases; in some, cauliflower-like masses have eroded the walls and invaded the surrounding peritoneal structures. In others there is ascites, and the fixation is slight, but, though it may be possible to remove both ovaries with the uterus, there is, as a rule, already secondary lymphatic involvement of the glands, and in a few months' time the patient succumbs from recurrence or cachexia. In every case of this nature it is imperative to obtain, therefore, expert pathological opinion upon the whole structure of the tumour before giving a prognosis.

ADENOMATA

These tumours are rare; they may be solid or, on section, contain small cystic spaces. It is probable that they arise from developmental relics (*Wolffian tubules*), though others consider that the cortical germinal cells are responsible.

The benign adenoma is composed of cell elements with an accurate histological reproduction of the cells of origin, whereas in the malignant type the cell elements show evidence of rapid division and proliferation, and there is invasion of the stroma by solid masses of heaped-up cells with multiple nuclei.

The tumours, whether innocent or malignant, are frequently bilateral, and the question arises whether the innocent type progresses, as a result of some stimulus, into the malignant type or whether the malignant type is carcinomatous *ab initio*.

The tumours are not uncommonly pedunculated and have a smooth



Fig. 1474.—A RAPIDLY GROWING SOLID ADENO-CARCINOMA OF THE RIGHT OVARY IN AN UNMARRIED WOMAN OF 22 YEARS. SHOWING HÆMORRHAGIC AREAS. ALIVE AND WELL WITH NO RECURRENCE 18 MONTHS LATE. COMPLETE HYSTERECTOMY PERFORMED.

marbled exterior. On section, they are soft and often brain-like, with hæmorrhagic areas, old and new, scattered through them. Figure 1474 was removed from a young woman of 22. It showed rapidly growing adeno-carcinoma. Complete hysterectomy was performed, followed by regular deep X-ray treatment. She was alive and well 18 months afterwards.

Personal experience indicates that these tumours are more often malignant than innocent, and that the degree of malignancy is very high; for instance, in one case, complicating early pregnancy in a woman of sixteen, removal was followed by death one month after full-term confinement from a secondary growth in the lung. In another, where no adhesions or ascites existed, where the tumour was no bigger than a grape fruit, and examination was only sought because menstruation had ceased, complete hysterectomy and removal of both ovaries followed by deep X-ray therapy at regular intervals did not prevent death eighteen months later from secondary growths in the spleen and abdominal glands.

There is another adenoma (*ovo-testis*) of extreme rarity and interest in that it contains multiple tubules exactly resembling the seminal tubules of the testicle. R. Meyer contends that they arise from embryonic testicular ectopic rests in the ovary, and may be responsible for such secondary male characteristics as are occasionally met with in women.

FIBROMATA

These tumours, like other connective tissue tumours of the ovary, are rare. They may occur in quite young women, and are most often associated with sterility. As a rule they are bilateral and have a dense fibrous consistency though areas of cystic degeneration may exist, as in figure 1475, which was removed from a nurse aged twenty-four. No evidence of ovarian substance can as a rule be detected in these tumours, and amenorrhœa is almost a constant symptom. Ascites is said to be a feature of ovarian fibromata when they arise above the brim of the pelvis, but I have frequently, as in the above case, noted its absence.

Expert histological examination of such tumours is necessary, for whereas in some, spindle cells are packed into areas separated by bands



Fig. 1475.—BILATERAL INNOCENT FIBROMATA WITH SMALL CYSTIC CAVITY IN RIGHT OVARY IN A NURSE OF 24 YEARS. NO ASCITES PRESENT.

of coarse fibrous tissue, in others irregular multiform nucleated spindle cells, with little fibrous tissue and areas of liquefaction, may give the appearance of a sarcoma. Indeed, in some the clinical after-history is the only criterion of value.

SARCOMATA AND ENDOTHELIOMATA

These tumours are exceedingly rare, and occur as a rule at an early age. They are frequently bilateral, grow rapidly, and give rise



Fig. 1476.—SARCOMA AND CYSTIC DEGENERATION IN LEFT OVARY OF A GIRL OF 15. WEIGHT OF TUMOUR 2 LBS. SIMILAR APPEARANCE IN RIGHT OVARY WHICH WEIGHED $\frac{1}{2}$ LB. DEATH 5 MONTHS LATER FROM MEDIASTINAL METASTASES.

ascites. They are very vascular and have large blood-vessels running over the surface. Most frequently they contain many small cystic spaces filled with blood or brain-like material, which, on section, show all varieties of spindle cells or rapidly-dividing embryonic cells, whose nuclei readily stain. The tumour in figure 1476 was removed by me from a girl of fifteen. It weighed 2 lbs. There was a smaller tumour weighing $\frac{1}{2}$ lb. in the right ovary. She lived five months and died of mediastinal metastases.

ENDOMETRIOMATA

These ovarian cysts of extrinsic origin are of interest both from a clinical and a pathological point of view, for their histological diagnosis depends upon the demonstration of true endometrial tissue in the lining wall of the cyst, and unless such tissue is found these chocolate cysts of the ovary belong to the corpus luteum cysts referred to on page 2638.

It is not necessary here to discuss fully their ætiology. The implantation theory of Sampson can be accepted as an explanation of some



Fig. 1477.—PURE ENDOMETRIAL CHOCOLATE CYST OF LEFT OVARY SHOWING ALSO POLYP AT FUNDS AND ADENOMYOSIS OF UTERINE MUCOUS MEMBRANE.

chocolate cysts, but it is far more probable that the serosal theory of Ivanoff, supported by the research of Wilfred Shaw and Nicholson, most adequately accounts for the majority of these tumours, which are, as a rule, bilateral, densely adherent, vary in size from a pea to a tangerine orange, and are often accompanied by other evidence of endometriosis, such as nodular growths in the recto-vaginal septum or pouch of Douglas, and occasionally by adenomyomata of the uterus.

Chocolate endometrial cysts frequently simulate old and chronic tubo-ovarian inflammatory collections of fluid, or tuberculous disease

of the adnexa; but a leucocyte count, a complement fixation test, or radiograph will as a rule permit a tentative diagnosis. Moreover, when doubt exists, further assistance may be gained by a protein-shock therapeutic test, that is, the intramuscular injection of 10 cc. of aolan. In the case of inflammatory cystic tumours there will be a rise in temperature, and a rise in the white blood count as a result of the

injection, whereas in the case of an endometrioma there will be no reaction.

These chocolate cysts of the ovary tend to increase slowly and to give rise to symptoms of pain at or about the time of each menstrual cycle, such symptoms being due to the fact that the metaplastic or implanted endometrial cells under the stimulus of the anterior pituitary secrete and necrose into the cavity of the cyst or cysts from month to month. Moreover, as the tension of this tarry hæmatocolpos-like fluid increases, it is not uncommon for one of these cysts to burst,

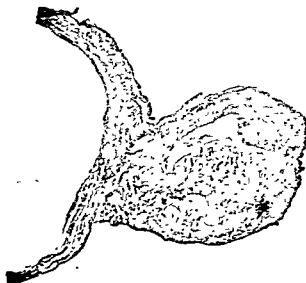


Fig. 1478.—ENDOMETRIOSIS OF THE OVARY. SECTION SHOWS, ON THE LEFT, A PORTION OF CYST-WALL FORMED BY THINNED-OUT AND COMPRESSED OVARIAN STROMA. JUST BEYOND THIS WALL IS A MASS OF TYPICAL ENDOMETRIAL TISSUE EMBEDDED IN OVARIAN STROMA. ABOVE THIS HIGHLY CONGESTED ENDOMETRIAL TISSUE IS A SMALL CYSTIC SPACE. BELOW, TWO OTHER SMALLER CYSTS ARE ALSO SEEN, OF WHICH THE ONE TO THE RIGHT SHOWS A GLANDULAR ACINUS NEAR ITS WALL.

and the fluid to extravasate into the pelvis (so far as adhesions will permit), giving rise to symptoms of intense pain, vomiting, and low fever, simulating appendicitis or diverticulitis, which may lead the general surgeon into the error of urgent operation.

Remembering that the ætiology of these tumours is that of implantation or metaplasia, that their growth depends upon sex hormones, and that they occur in about 12 per cent of all gynaecological lesions, it is important to realise that, although they may cease to cause trouble

after the menopause, they are a very constant source of invalidism from 30 to 45 years of age, for, apart from the risk of rupture, they tend to invade the bladder, vagina and pelvic colon, giving rise to symptoms simulating cancer of these structures.

In the early stages the symptoms are those of backache or dysmenorrhœa, menorrhagia, or dyspareunia.

Treatment is essentially surgical, though X-rays and radium, with a view to determining artificial menopause and thereby a natural cure, have had their advocates. Such means cannot be recommended in the absence of a certain diagnosis, which can only be made after laparotomy.

At operation one or other of the chocolate cysts invariably ruptures. Its contents must be carefully swabbed up, for otherwise fresh peritoneal contamination and growth of endometrial cells may occur.

Bilateral removal of both appendages with the uterus and ovaries is, as a rule, indicated in an advanced case, but, in the presence of a

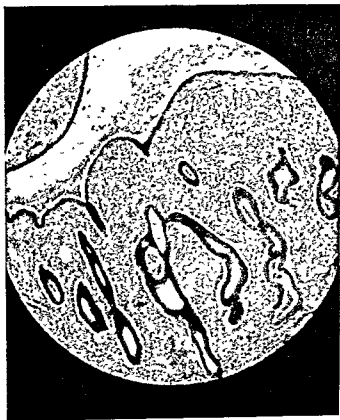


Fig. 1479.—ENDOMETRIOSIS OF THE OVARY. HIGHER MAGNIFICATION OF A PORTION OF THE ENDOMETRIAL TISSUE.

recto-vaginal adenomyoma, it is never wise to risk complete removal of the uterus for fear of injury to the rectum, because removal of both ovaries, by bringing about the menopause, arrests progress of the disease and causes retrogressive changes in such tumours.

In a lesser state of endometrial cystic disease of the ovaries, I have always endeavoured to conserve a healthy portion of one or other ovaries, for, having removed all diseased structure, it is by no means uncommon for spontaneous regression to occur, though at times subsequent operation may be found necessary. For instance, in the case of figure 1478 the first operation in 1925 was removal of the left ovary, part

of the right ovary was resected in 1931, and subsequent removal of the remaining portion adherent to the right cornu of the uterus took place in 1934.

Endometriomata are very rarely malignant, and most usually are found in women who are sterile or who have had no children for several years.

HYPERNEPHROMATA

These tumours are not very uncommon and owe their origin to the fact that the embryonic ovary lies close to the kidney, some cells of which may be included. The tumour is as a rule unilateral, lobulated, and has a peculiar lemon-coloured appearance. On section, areas of hæmorrhage and necrosis are frequently seen. They are not markedly malignant. In two cases of my own no ovarian substance could be differentiated and the cell structure was typical of the suprarenals; they were both alive five and seven years later.

METASTATIC MALIGNANT OVARIAN TUMOURS

It has long been recognised that carcinoma in almost any part of a woman's body may show secondary deposits sooner or later in the ovaries. This is particularly true of breast cancer, and I have seen many such cases, but perhaps the most interesting growth of all is the Krukenberg tumour which may occur in the ovary without any suspicion of a primary growth in the stomach. These tumours are not always bilateral and are smooth, solid, and somewhat lobulated. Rarely are there any adhesions. The discovery of such a tumour should always make the surgeon investigate the stomach area, for frequently the primary gastric carcinoma is of insignificant size and may have given rise to few symptoms. On section, the epithelial cells are large and in clusters. Their nuclei are eccentric, giving rise to the so-called "signet-ring" appearance. Removal of these tumours does not, of course, stay death.

These tumours are not common. Metastatic carcinoma from the large intestine and uterus to the ovary is, however, comparatively often seen.

FIMBRIAL OR PAROVARIAN CYSTS

These are terms given to cysts which originate from developmental remains in the neighbourhood of the ovarian fimbria of the Fallopian tube and broad ligament. They are easily identified because the

Fallopian tube and its ovarian fimbriæ are elongated and arched over the upper surface of the tough but thin-walled cyst. Occasionally the cyst is pedunculated, but more often it burrows retroperitoneally into the broad ligament, displacing the bowel, uterus or ureter. The cyst depicted in figure 1480 is unilocular and unilateral, and the ovary and tube can be seen discretely stretched out on its outer surface. The contents are clear, contain little albumen, and have a low specific gravity. The lining membrane consists of columnar epithelium, and very rarely warty papillary growths may be found which do not tend to proliferate or erode the cyst wall. These cysts never become malignant, and are very rarely subject to torsion.

Surgically, it is important to realise that these tumours can as a rule be shelled out of the broad ligament without difficulty, and that rarely is it necessary to sacrifice or remove the ovary which is on its outer surface. Sometimes when the tumour is large and long-standing, and has grown downwards and outwards in the broad ligament, displacing bowel, bladder or uterus, the lower pole of the cyst may become densely adherent to the floor of the pelvis, and during removal considerable venous oozing may result from the deep plexuses of the broad ligament, which will need careful ligature or underpinning. Moreover, as the ureter may be greatly displaced care must be taken not to cut or tear this structure, which may be seen, tortuous and elongated, on the outer surface of the tumour.

Many cases have been recorded of cutting or ligation of the ureter. It is important for the gynæcologist to realise the danger and be prepared to deal with the condition at once. Experience has shown that the best results are obtained not by anastomosis, which is a difficult and frequently futile performance, nor by direct implantation of the cut end into the bladder wall, but by transplanting the proximal end of the ureter into the sigmoid colon, using either the technique of Coffey, Nitch, or myself, as described in the *British Journal of Surgery* and *Royal Society Transactions*.

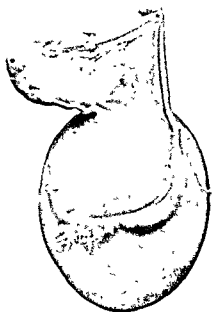


Fig. 1480.—FIMBRIAL CYST WITH FALLOPIAN TUBE STRETCHED OVER IT AND OVARY QUITE DISCRETE.

RUPTURE OF CYSTS

In Europe, owing to the fact that tumours are rarely permitted to reach a large size, this feature is a rare one but it is by no means infrequently met with in tropical countries.

Spontaneous rupture may, however, occur as a result of local degeneration, innocent or malignant, in the wall of a cyst of moderate size, the effects thereof being dependent upon the contents of the cyst. If serous, the symptoms will be transient and those of local peritonitis, but if pseudo-mucinous the result may be a pseudo-myxoma peritonei. On the other hand, papillary growths, innocent or malignant, may implant and grow upon any structure within the peritoneum, giving rise to secondary ascites.

In my experience rupture of a cyst is as a rule a silent process or, at the most, gives rise to but transient symptoms, the site of rupture not being discovered until operation at a later date, though, of course, if the contents are infected material, urgent symptoms will present themselves.

Occasionally the bursting locus is single and very large. In such a case, and I have recorded four instances of this, the symptoms are those of shock and the curious disappearance of the tumour is accompanied by marked enuresis. Later, symptoms of irritative peritonitis occur.

Under the heading of endometriomata I have referred to the symptoms which occur as a result of the rupture of a chocolate cyst of the ovary, and have observed that the signs and symptoms thereof are very frequently diagnosed as those of appendicitis or diverticulitis, which leads to emergency operations by general surgeons who are unacquainted with pelvic pathology and symptomatology.

MORTALITY

The removal of an ovarian tumour can be, like that of the appendix, the easiest or one of the most difficult operations in surgery. Perhaps this is most readily understood when we compare the results of hysterectomy with those of ovariectomy. The mortality of hysterectomy is under 2 per cent for fibromata, whereas that for removal of tumours of the ovary is approximately 5 per cent in all countries.

CLINICAL FEATURES OF OVARIAN TUMOURS

It is not necessary to enumerate these fully, but it is a matter of some interest to observe that, in a consecutive series of 547 cases of my own which I recorded in 1931, only 24 per cent complained of pain, whereas 61 per cent sought relief because the abdomen was enlarging. Uterine bleeding was a symptom in 17 per cent, and of these the bleeding was post-menopausal in 6 per cent.

Pain is not a prominent symptom unless simple or malignant degeneration has occurred with involvement of the peritoneum, but, of course, if torsion, infection, or rupture of a tumour occurs, pain is an obvious feature due to reactive peritonitis. In my own series torsion was present in 12 per cent.

Ascites is much more commonly present than is generally recognised, and in my experience it is as often associated with innocent as with malignant tumours. Ascites is rarely present unless the tumour is either bilateral or above the brim of the pelvis. The peritoneal exudate may be a chemical or irritative reaction. Cytoscopic examination of such ascitic fluid after a small paracentesis is of considerable prognostic value before operation. I use a hypodermic needle and syringe.

Malignant changes, whether primary or secondary, are far from uncommon. In my own series 21.4 per cent were malignant. Such high incidence is partly due to the fact that in the East patients delay coming to operation, and this justifies the opinion that such hesitation predisposes to secondary malignant changes. H. R. Spencer records a 10 per cent malignancy rate, whereas Lippert's is 15.5 per cent.

Seventy-five per cent of malignant tumours of the ovary are bilateral, and a high percentage of these patients suffer from primary sterility. Seeing that there is no direct blood or lymph communication between the two ovaries, the explanation of primary bilateral tumours would seem to lie outside the pelvis and most probably in the hypophysis, for many of these tumours give rise to a positive prolan reaction.

It is not improbable that malignancy is more common than has hitherto been recognised, for in a large tumour it is very easy both for surgeon and pathologist to miss small areas of malignancy. Such changes may, however, be suspected clinically if a tumour, previously symptomless, becomes painful, fixed, and associated with ascites. It is particularly important that especial care should be taken in the case

of papillomatous tumours, for, as has been said under that heading, the finding of a papilla with a cell-strewn stroma and heaped-up irregular mitotic surface cells is significant of malignancy and demands removal of both ovaries and usually a follow-up with deep X-rays.

INFECTION

This is by no means uncommon and occurs through the blood or lymph stream, or by direct contact from the bowel, appendix or tubes. It is frequently seen in the case of twisted tumours and cysts discovered after abortion or labour. I have seen it in the course of typhoid fever and as a result of septic tonsils.

The organisms found are most often streptococci and *B. coli*. But any other pyogenic organism may be the cause.

Symptoms vary in intensity and may be local or general according to the size and position of the tumour and variety of the organism. For instance, a dermoid infected and impacted in the pelvis after labour or abortion may simulate plastic pelvic peritonitis; whereas a tumour above the brim of the pelvis may be only partially infected, or only one loculus affected, with the result that diagnosis, apart from pain, fever and leucocytosis, is not easy until the infected loculus reaches the surface of the tumour or bursts, giving rise to obvious and intense inflammation of the peritoneum.

Operation is fraught with considerable mortality, for in freeing an infected tumour there is great risk of the cyst bursting and flooding the peritoneum with virulent organisms.

In a recent case of mine, the tumour was infected with tubercle bacilli from tubercular pus tubes. Dense adhesions were present, making adequate removal extremely difficult. After two weeks a tuberculous fistula formed, and one month later a faecal fistula occurred which showed no signs of healing after five months. Subsequently, tuberculosis of the lung showed itself with rapidly fatal result.

OVARIAN TUMOURS AND PREGNANCY

The incidence of this association is important. It occurred in 29 out of 547 personal cases. In 16 the cyst was serous, in 9 it was a dermoid, in 3 it was pseudo-mucinous, and in 1 malignant. These figures correspond fairly closely with those of H. R. Spencer.

Ovarian tumours are more liable to torsion, both during and after pregnancy. If seen in the early months of pregnancy operation is

rarely followed by abortion. The optimum time for operation is about the fourth month. If, however, the case is not seen until pregnancy is advanced it is best, unless urgent symptoms are present, to wait until nearly full-term and then to remove the baby by Cæsarean section, the tumour being removed at the end of the operation.

Occasionally, where ante-natal care has been defective, ovarian tumours are not diagnosed until late in labour, and then only because labour is obstructed. If dystocia exists, Cæsarean section is the best treatment, though cases have been recorded where circumstances compelled vaginal puncture of the tumour with success. In the event of the tumour being entirely abdominal, and therefore causing no obstruction, the attendant must be alive to the fact that such tumours add to the dangers of the puerperium from torsion, infection or rupture. Many surgeons, therefore, prefer to operate immediately after the baby is born rather than run such risks. These dangers are in my experience considerably enhanced in the case of abortion.

GENERAL CONSIDERATIONS OF TECHNIQUE

Patients with ovarian tumours are frequently wizened or cachetic, and, since their blood-pressures tend to be low, prolonged operations, particularly in the Trendelenburg position, should be avoided. It is well to keep such patients in bed for several days before operation in order to estimate heart and kidney function.

Blood-transfusion or intravenous glucose should be given before or during operation if need be.

Spinal or avertin anæsthesia in the case of large tumours gives the best results.

In the case of small tumours no bigger than a tangerine orange, mobile in the pelvis of a multipara, they can be removed per vaginam through the pouch of Douglas. In the case of large tumours, the abdominal incision should be from 10 to 12 inches long. The surgeon should first separate soft adhesions between the tumour and the parietal wall so far as is possible with the hand, for by so doing there is less shock and less likelihood of pulling upon the omentum. At the same time, with a hand reaching down into the pelvis, he should discover the position and relation of the fundus uteri to the tumour, for this will enable him to determine whether the tumour is unilateral, pedunculated or retroperitoneal.

In making large incisions, it is necessary to take care that the bladder is not injured for in some tumours, particularly those of the

broad ligament, the bladder may be pulled up as high as the umbilicus and therefore may easily be incised.

When possible, the tumour should be everted entirely out of the abdominal incision without rupturing or tapping it. Using a dry swab, it is then usually quite easy to separate adhesions of the omentum and intestines which are frequently present on the fundus and posterior surface of the tumour. Where needed, vessels are ligated with catgut.

In the event of the gut being greatly involved in, or adherent to, the wall of the tumour, it is rarely necessary to resect such intestine for, if a thin incision is made along the fibrous wall of the tumour one inch away from and parallel to the adherent bowel, the gut can be freed with a dry swab along with a portion of the outer fibrous wall of the cyst.

Occasionally the immense size of the tumour does not permit of eventration. In such a case one or more loculi must be tapped first, but it should be remembered that the contents of any loculus which ruptures or is tapped may be infected or contain malignant cells.

Large broad ligament cysts often give the greatest anxiety, for the bowel, bladder or ureter are frequently displaced and may be torn or cut. Indeed, it is no uncommon thing to find the ureter and colon displaced high up over the anterior surface of a retroperitoneal cyst. In many of such cases the ureter has unwittingly been cut with fatal results. If, however, the surgeon should cut the ureter, instead of wasting time attempting ureteric anastomosis, it is better to implant the proximal end of the ureter into the colon by the method described by Coffey, Nitch, or myself.

There is usually a great deal of shock following the opening up of large raw areas in the case of broad ligament cysts. This should be foreseen and guarded against by blood or glucose transfusion. Moreover, the big veins at the base of the broad ligament where the tumour is adherent may give rise to much hæmorrhage necessitating underpinning, using either a Worrall needle or a curved needle threaded backwards.

In the cases of a large broad ligament tumour with gross displacement and adherence of the uterus, the easiest, quickest, and least hæmorrhagic method of removal is, having tied the infundibulopelvic ligament of the tumour, to amputate the uterus above the cervix, commencing on the healthy side of the organ and working from below upwards under the capsule.

In every case, after removal of the primary tumour, the opposite

ovary should be inspected. Bilateral tumour formation is very common, but, during the reproductive period of life unless malignancy is obvious, every endeavour should be made to conserve some healthy portion of ovary, for, in the case of cysts and innocent papillomata which may be advanced in one ovary and perhaps only commencing in the opposite organ, it is well to remember that nearly all neoplasms tend to grow away from the hilum. This fact enables the conscientious surgeon, as a rule, to conserve a healthy functional portion of ovary.

On the other hand, after the menopause the necessity for such conservation does not exist; therefore, if in doubt it is better to remove both ovaries and the uterus.

In the case of papillomatous tumours with secondary peritoneal outgrowths, it is by no means uncommon for such deposits or metaplastic areas to disappear after removal of the parent tumour, although at the time of operation, before microscopic section, malignancy was suspected.

When dealing with a simple pedunculated ovarian tumour, the ligated pedicle should be buried in the folds of the broad ligament. The uterus should be ventro-fixed or suspended before closing the abdomen so as to prevent it from retroverting and giving rise to future symptoms.

All raw surfaces should be peritonised as far as possible and oozing tags ligatured where seen. Before closing the abdomen, the omentum should be brought down to the pelvis, and each kidney pouch in the loin swabbed dry, for jellified blood and serum tend to collect there.

In some of these cases, it is well to remember that it requires greater moral courage to stop and close the abdomen in the early stages of an operation, when you find the condition grossly inoperable or malignant, than to proceed and kill the patient thereby on the table.

X-rays, radium, or the selenide treatment of Dr. Todd may prolong life in some cases of malignancy.

In the tropics where mammoth tumours are the rule rather than the exception, a period of great anxiety may occur during operation when the tumour is eviscerated or tapped, from a sudden drop in blood-pressure or from a sudden movement of the heart downwards as a result of the relaxation of tension upon the diaphragm; such movement of the heart with sudden alarming symptoms being similar to that seen when a large pleural effusion is too rapidly emptied. This may be prevented by passing a long roller towel around the patient immediately over and slightly below the limits of the costal margin. One nurse or dresser takes each end, and as the tumour is

removed or emptied gentle gradual compression of the abdomen is made by pulling upon the towel. By this means the abdominal pressure is maintained and filling up of the splanchnic vessels due to a negative pressure, consequent upon the emptying of the abdomen, is prevented. Moreover, any sudden downward movement of the heart as a result of release of tension is checked.

Another feature of such large tumours is cyanosis due to pressure on the base of the lung and diaphragm. For this reason spinal or avertin anaesthesia gives the best results.

In my experience post-operative embolism is exceedingly rare after ovariectomy unless infection or malignancy is present.

Some surgeons in the case of large tumours are in the habit of removing large areas of skin when sewing up the abdomen. I consider this needlessly adds to the shock of operation.

Post-operative ventral hernia is a very exceptional occurrence.

All patients are urged to move about in bed, do arm and leg exercises, and take deep breaths from the moment of recovery from anaesthesia. They are also encouraged to get out of bed with a tight six- to eight-inch crêpe-velpeau abdominal bandage around them about the tenth day. I am sure that these measures reduce the incidence of post-operative embolism and thrombosis.

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PART XI

URINARY SYSTEM AND MALE
GENITAL ORGANS

by
J. C. AINSWORTH-DAVIS

CHAPTER I
*The Investigation of a Patient with Genito-Urinary
Symptoms*

CHAPTER II
Diseases of the Kidney

CHAPTER III
Diseases of the Ureter

CHAPTER IV
Diseases of the Bladder

CHAPTER V
Diseases of the Prostate Gland and Seminal Vesicles

CHAPTER VI
Diseases of the Penis, Testis, Scrotum and Adnexa

CHAPTER VII
Diseases of the Urethra

INTRODUCTION

THE modern methods of examination and diagnosis of a disease giving rise to urological symptoms constitute one of the most interesting and important investigations of the present time. The great advances which have been made in the perfection and application of urological instruments, such as the cystoscope; corresponding improvement in radiological technique; and the more exact knowledge of the pathology of the various diseases which attack the urinary system, all help to ensure accurate diagnosis. Pre-operative treatment, anticipation of complications, and a well-planned operation with methodical and careful after-treatment have done much to reduce mortality and place the comparatively new science of urology in the position which it justly deserves. To the urological departments which are being established in the various hospitals, and to those hospitals specialising in the subject, must be attributed the increasing knowledge of both student and post-graduate, resulting in greater benefit to the patient. An accurate knowledge of urological symptoms and routine examination will, in many cases, allow a satisfactory diagnosis to be made while the disease is still in its early stages, and before any complications have set in, thus minimising the severity of the operative or instrumental procedure necessary to effect a cure. The importance of close co-operation between patient, practitioner, urologist, radiologist and bacteriologist is essential, and cannot be over-emphasised. A genito-urinary surgeon must possess a sound knowledge of all urological procedures and the ability to carry them out, and should have in his mind during the investigation of a case a clear conception of the order and progress of the inquiries to be pursued. It is proposed, therefore, to devote Chapter I to the investigation of a patient with genito-urinary symptoms, this being followed by a description of the more important diseases of the urinary tract, including their treatment.

INTRODUCTION

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CHAPTER I

THE INVESTIGATION OF A PATIENT WITH GENITO-URINARY SYMPTOMS

THE investigation of a patient with genito-urinary symptoms should be conducted according to a definite plan which has for its object the

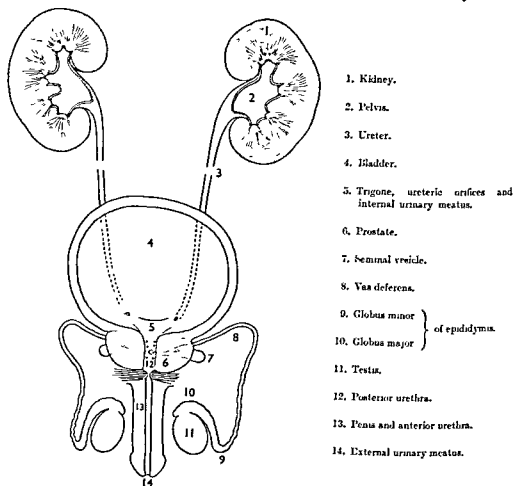


Fig. 1481.—DIAGRAMMATIC VIEW OF MALE URINARY TRACT.

determination of the exact nature, situation and extent of the disease which has produced these manifestations of its presence.

A short but accurate past history, a detailed but relevant account of the symptoms, together with a properly conducted enquiry into the

functions of the urinary and genital tract as a whole, will suggest to an observer, gifted with a reasonable amount of clinical instinct, a provisional diagnosis. This is followed by a routine examination in order to discover signs of the alleged symptoms and to determine the presence of disease in such parts of the genito-urinary system as are accessible by simple means. The information obtained at this stage will either be sufficient to make a diagnosis, or to indicate which of the special urological examinations is required to do so.

To these special examinations must be attributed the precision to which urology has attained at the present time, and considerable space will be allotted to their description. By their means, not only is the exact nature of the urinary disease established, but also definite indications obtained for treatment, whether of a conservative, instrumental or operative type.

The following table is a summary of the investigations to which reference has just been made, together with the order in which they are carried out.

INVESTIGATION

The patient is directed not to pass water, if possible, for 2 or 3 hours before examination.

(1) *History.*

- (a) Sex, age, and whether previously resident abroad.
- (b) General statement of symptoms.
- (c) Venereal history : gonorrhœa or syphilis.
- (d) Menstrual history : children, miscarriages, periods, vaginal discharge and backache.
- (e) Digestion and bowels.

(2) *General Symptoms.*

- (a) Of any disease giving rise to urological symptoms : e.g. tabes, purpura.
- (b) Of renal failure.
- (c) Of malignant disease of urinary organs.

(3) *Upper Urinary Tract Symptoms.*

- (a) Renal pain.
- (b) Renal colic.
- (c) Backache.

(4) *Lower Urinary Tract Symptoms.*

- (a) Frequency.
- (b) Hæmaturia.
- (c) Pain. $\left\{ \begin{array}{l} \text{Vesical.} \\ \text{Prostatic.} \\ \text{Urethral.} \end{array} \right.$
- (d) Character of micturition.
- (e) Difficulty.
- (f) Retention (or suppression).
- (g) Incontinence.
- (h) Sexual disturbances.
- (i) Character of urine.

(5a) *Routine Examination of Males.*

- (a) Penis, prepuce, and external urinary meatus.
 - (b) Scrotum.
 - (c) Rectal examination. Knee-elbow.
 - (d) Act of micturition and urine.
 - (e) Administration of local anæsthetic.
 - (f) Abdominal examination :
 - (i) Renal areas.
 - (ii) Bladder area.
 - (g) General examination :
 - (i) For signs of renal failure.
 - (ii) For other diseases with urological symptoms.
 - (iii) For secondary deposits.
 - (iv) For evidence of nervous diseases, e.g. tabes.
 - (h) Catheterisation and residual urine.
- } Standing.
- } Lying.

(5b) *Routine Examination of Females.*

Lithotomy position, good headlight, sit between thighs.

- (a) Urethra (smears if necessary).
 - (b) Catheter specimen.
 - (c) Cervix, inspection through bivalve speculum (smears if necessary).
 - (d) Bimanual examination.
 - (e) Abdominal examination.
 - (f) General examination.
- } As for males.

(6) *Special Examinations.*

- (a) Chemistry, cytology, bacteriology, and animal inoculation of the urine.
- (b) Anterior urethroscopy.
- (c) Posterior urethroscopy.
- (d) Cystoscopy and chromo-cystoscopy.
- (e) Ureteric catheterisation.
- (f) Plain X-ray.
- (g) X-ray with opaque ureteric catheter.
- (h) Intravenous pyelogram.
- (i) Ascending pyelogram.
- (j) Renal function tests.

- (1) *History.*
- (a) Sex, age, and, whether previously resident abroad.
 - (b) General statement of symptoms : situation, date of onset.
 - (c) Venereal history : gonorrhœa, or syphilis.
 - (d) Menstrual history: children, miscarriages, periods, vaginal discharge and backache.
 - (e) Digestion and bowels.

(a) *Sex, age, and previous residence abroad.* Certain diseases are naturally confined to one or other sex, while others are more common in males than in females or vice versa. Some occur during adolescence, some in middle life, and others only in old age though giving rise to similar symptoms. Thus, acute retention is most commonly due to gonococcal infection in young men, to stricture in adults, and to prostatic obstruction in males over the age of 55.

Details of previous residence abroad may be of some assistance, as hot, dry climates are known to be a predisposing factor in the formation of stone, and an infection due to *Bilharzia* may have been acquired in Egypt.

(b) *General statement of symptoms.* A note should be made of the chief symptoms together with their situation, date of onset, severity, duration, and order of appearance.

(c) *Venereal history.* An inquiry into a past attack of gonorrhœa or syphilis is of great importance, as the former is the chief cause of

stricture or prostatitis, while the latter may throw light on an obscure case of incontinence.

(d) *Menstrual history.* In female patients, the number and dates of past pregnancies or miscarriages should be ascertained, together with the date of the last period, and a note made of any irregularity or other abnormality of the menses, and the presence of vaginal discharge and backache.

The female genital tract is so often the source of both upper and lower urinary inflammations, that even minor disturbances demand the most careful investigation.

(e) *Digestion and bowels.* Gastro-intestinal symptoms are common in renal failure, and thus the presence of thirst, indigestion, or diarrhoea should put the observer on his guard.

(2) *General Symptoms.* (a) Of any disease giving rise to urological symptoms: e.g. tabes, purpura.

(b) Of renal failure.

(c) Of malignant disease of urinary organs.

(a) *Of any disease giving rise to urological symptoms, e.g. tabes or purpura.*

The chief symptoms of *tabes dorsalis* are lightning pains (often described as rheumatism), gastric crises, and impotence. *Disseminated sclerosis* gives rise to different symptoms in different cases; the most frequent are: visual (attacks of diplopia or of amblyopia) and weakness of the legs. *Mitral stenosis* severe enough to be a cause of embolism is accompanied by dyspnoea, while cough and hæmoptysis are not uncommon. *Sub-acute bacterial endocarditis* causes an insidious illness, with such symptoms as weakness, vague pains, etc. *Scurvy* has also an insidious onset with weakness, dyspnoea on exertion, listlessness, bleeding from the gums, and pain in the legs. There is usually a history of gross dietary deficiency. The patient with *purpura hæmorrhagica* notices bleeding from the nose or other mucous cavity (e.g. uterus), and observes the petechial rash.

(b) *Of renal failure.* These are: (i) nervous: headache, drowsiness, amaurosis, pruritus, insomnia; (ii) respiratory: attacks of dyspnoea; (iii) gastro-intestinal: thirst, dyspepsia, anorexia, vomiting, diarrhoea and colitis. Under treatment the dyspepsia may improve, but without relief of the vomiting.

(c) *Of malignant disease of the urinary organs.* Obstruction of the vena cava with œdema of the lower limbs may occur in *hypernephroma*. As in other cases of malignant disease, a terminal cachexia (anæmia plus wasting) may develop in patients suffering from malignant disease of the urinary tract. Spontaneous fracture of a bone, the seat of a *secondary deposit*, may occur.

(3) *Upper Urinary Tract Symptoms.* These consist of renal pain, renal colic, and backache, which may exist separately or be combined.

Renal pain. The renal parenchyma is devoid of sensory nerves, as has been shown during operations on the kidney under local anæsthesia, when puncture or incision can be carried out without giving rise to any painful sensations. Sensory nerves, however, are present in the renal capsule and in the walls of the renal pelvis, and any increased tension of either the capsule or the pelvis will produce pain. The cause of increased tension of the pelvis is always obstruction, due to blocking of the pelvic outlet by a stone, to inflammatory swelling of the mucous membrane at the pelvi-ureteral junction, or to spasm of the musculature of the ureter. Distension of the capsule which may result from any condition causing rapid enlargement of the kidney, as may occur in some forms of nephritis, has led to the operation of decapsulation for the relief of this symptom. Renal pain, usually felt in the back of the loin, sometimes occurs in the front, or may be present in both places at the same time. Post-renal pain is a persistent aching, of varying severity, high up in the lumbar region, with a point of maximum intensity in the angle between the outer border of the erector spinæ muscle and the twelfth rib. It tends to pass forwards through the loin. *Hyperæsthesia of the overlying skin* is a common accompaniment. Anterior renal pain is referred to a point on the outer side of the rectus muscle about one inch below and internal to the tip of the ninth rib.

Renal colic. This is produced by irregular spasmodic contractions of the musculature of the ureters in an attempt to propel their contents downwards towards the bladder. The pain varies in severity from agonising paroxysms accompanied by collapse, sweating and vomiting, to colicky pains of moderate degree. It is referred along a line on the anterior abdominal wall, corresponding to the ureter, following the outer border of the rectus muscle very closely, and radiating along the distribution of the genito-crural nerve to the front of the thigh, to the testicle in the male and to the labium majus in the female. Contraction

of the cremaster muscle causes retraction of the testicle, which may be exquisitely tender for hours or even days after the cessation of the colic. The severity of the pain varies in proportion to its cause, being greatest in some cases of ureteric calculus and least if due to the passage of blood clot, or of tuberculous or other debris down the ureter. The situation of the colic varies with the level in the ureter of the foreign body or material responsible, the upper limit of the pain roughly corresponding to this point. In all cases the pain radiates downwards and never in an upward and inward direction. Renal colic is usually associated with varying degrees of post-renal pain, due to distension of the kidney by urine from the blocking of the ureter. This pain can be temporarily relieved by the passage of a ureteric catheter, providing the obstruction can be negotiated.

Backache. This, not strictly an upper urinary tract symptom, is far more common in the female than in the male. It usually indicates some abnormality of the genital tract and demands careful gynæcological investigation. As will be seen later, displacements and inflammations of the reproductive organs often have an important relation to both upper and lower urinary tract diseases.

(4) *Lower Urinary Tract Symptoms.* These are best classified under the following headings :

- | | |
|-------------------------------|---------------------------------|
| (a) Frequency. | (f) Retention (or suppression). |
| (b) Hæmaturia. | (g) Incontinence. |
| (c) Pain. | (h) Sexual disturbances. |
| (d) Character of micturition. | (i) Alteration in the character |
| (e) Difficulty. | of the urine. |

It is usually on account of one of the foregoing that the patient seeks advice, the severity of one particular symptom often being such as to overshadow the others. The object of the investigator is not only to obtain an exact description of this particular symptom, but to inquire in detail into all others, and to consider such information as a whole. It is only by so doing that a provisional diagnosis can be arrived at which will largely influence the subsequent routine examination and determine which particular type of special examination is indicated. For the full appreciation of these individual lower tract symptoms an accurate knowledge of their causation is essential, and thus each will be described in turn.

FREQUENCY

In the normal male the act of micturition occurs five or six times during the day, in the female four to five. No water is passed during the night unless an unusual amount of fluid is taken before retiring. The amount of urine passed averages 50 oz. in the 24 hours, about 10 oz. being passed at a time.

If the fluid intake is increased, it follows that more urine will be secreted, and this in turn will give rise to physiological frequency.

All other causes of frequency are pathological and, in the majority of cases, are found in the urinary tract itself, but certain extra-urinary diseases which give rise to urinary symptoms must not be overlooked.

Diseases which directly or indirectly affect the bladder or posterior urethra, or interfere with the normal act of micturition, cause frequency to a greater or lesser extent. It is convenient to tabulate such diseases and the ways in which this result is brought about.

During routine examination most urethral and genital, and many intravesical causes will be found. Upper urinary and the remaining bladder diseases require special examinations, such as cystoscopy and pyelography.

Diseases of the kidney can affect the bladder in one or more of three ways, namely, by the production of polyuria, by infection, or by reflex irritation, each of which causes frequency. Thus in pyelonephritis there is an increase in quantity of urine due to some degree of renal insufficiency, and also infection which gives rise to secondary cystitis. In renal calculus there may be reflex irritation of the bladder. In movable kidney there may be reflex irritation of the bladder and polyuria.

Vesical conditions can also cause frequency in one or more ways. Thus a stone can irritate the bladder wall and at the same time determine an attack of cystitis, while a malignant growth may produce nerve involvement and cystitis.

In most cases, frequency is associated with other urinary symptoms which must all be considered together, for by so doing the diagnosis is considerably facilitated. Thus frequency accompanied by terminal hæmaturia and pain referred to the end of the penis is suggestive of acute cystitis when pyuria is present, but of a vesical calculus when it is absent.

Cystitis is only one of the causes of frequency, and failure to carry out a complete investigation may result in grave consequences to the patient should such conditions as renal tuberculosis or early malignant disease of the bladder be missed.

TABLE

CAUSES OF FREQUENCY

POLYURIA, OR INCREASE IN QUANTITY OF URINE	CAUSES OF FREQUENCY	
	Functional, e.g. fear: anxiety before a race or examination. Extra-urinary disease, e.g. diabetes, tuberc. Disease of the kidney, causing some degree of renal insufficiency	Non-Bacterial Bacterial—see Inflammation.
Polyuria, or increase in quantity of urine	Chronic interstitial nephritis, Polycystic kidney. Hydronephrosis. Movable kidney (polyuria following Dietl's crisis). Growth.	
BLADDER	Contraction	Constitutional Due to long-continued chronic cystitis.
	Irritation	Direct Reflex
Inflammation	Non Bacterial	{ Vesical calculus or foreign body. Ureterocoele—cystic dilatation of lower end of ureter. Alteration in character of urine:—phosphaturia, oxaluria, high acidity. From kidney, e.g. calculus, or movable kidney, etc. From ureter, e.g. calculus. From rectum, e.g. worms. Congestion secondary to appendicitis or salpingitis. Trigonitis secondary to chronic cervicitis or urethritis in the female.
	Bacterial	{ Usually <i>D. coli</i> cystitis. Less commonly staphylococci, streptococci, bacillus proteus, very rarely <i>Bilharzia</i> . Kidney:—Pyelitis, pyelonephritis, pyonephrosis. Bladder:—Growth, stone, vesico-intestinal fistula. Prostate:—Prostatitis and vesiculitis, prostatic abscess, prostatic calculi. Posterior urethra:—Urethritis, usually gonococcal.
Involvement of nerve supply	Primary	Secondary to urinary obstruction.
	Secondary	
Pressure from without		{ Malignant growths of bladder or prostate. Invasion by growths from without: carcinoma of cervix or bowel. Pregnancy, especially retroverted gravid uterus. Fibroids or other uterine tumour. Ovarian cysts.
Urinary obstruction, with or without residual urine		{ Prostatic enlargement. Fibrous prostate. Malignant prostate. Cystocoele. Stricture.

Frequency in a young adult with a sterile acid urine containing pus should always be regarded as being due to renal tuberculosis until this is excluded.

In some cases frequency is more marked during the day ; in others no such distinction is present. The former condition is characteristic of stone uncomplicated by cystitis, the erect position and jolting causing increased irritation of the trigone ; while in the recumbent position the calculus rolls back to the less sensitive areas and may cause very little trouble.

Inflammatory affections of the bladder usually result in frequency, which is equally marked by day and by night. Inflammation of the bladder may be secondary to inflammations of the cervix, appendix, Fallopian tubes, etc. It may be bacterial or non-bacterial. Chronic cervicitis results in the frequency, dysuria and backache, usually with a sterile urine, which form such a common triad of symptoms in women who have borne children.

HÆMATURIA

Hæmaturia, or the passing of blood in the urine, is one of the most important urological symptoms, and is produced by a variety of pathological conditions which may occur in widely different parts of the urinary tract. It must be emphasised, however, that many of these conditions can be present without causing hæmaturia, at all events for some time, and thus this symptom calls for immediate investigation to determine its site and causation while the bleeding is still in progress. Only too frequently is the patient given a bottle of medicine and told "not to worry as the bleeding will soon cease." Unfortunately another attack may not occur for months, by which time a more serious view is taken of the matter and a proper examination made, often with the diagnosis of an inoperable renal growth which might have been successfully removed at the earlier date.

There are two main types of hæmaturia. In the one the bleeding is painless, and in the other it is accompanied by pain which, of course, varies according to its site of origin. Of the two, the painless variety attends the majority of growths of the urinary tract, and is of much graver import.

The following table summarises the more important causes and sites of both types, together with their relationship to the act of micturition.

In both varieties stress is laid on the appearance of the blood in relation to micturition, and this is of great practical value.

If blood appears at the beginning of the act it must obviously come from the urethra, and this calls for urethroscopic examination,

TABLE
CAUSES OF HEMATURIA

	<i>Relation to micturition.</i>	<i>Site.</i>	<i>Causation.</i>
Painless	At Beginning —	Urethra	Growth (v. rare).
	At End —	Bladder	Growth. A few cases of stone. Enlarged, congested prostate.
	Mixed ←	Ureter	Growth (v. rare). Ureterocele (rare).
		Kidney	Growth. Stone. Tuberculosis. Hydronephrosis. Pyonephrosis. Congenital cystic disease.
		Pre-renal	Purpura. Arterio-sclerosis.
Painful	At Beginning —	Urethra	Acute urethritis. Caruncle.
	At End —	Bladder	Cystitis. Stone. Malignant Growth.
	Mixed ←	Ureter	Stone. Blood clot.
		Kidney	Pyelitis. Pyelonephritis. Hydronephrosis. Pyonephrosis. Stone. Tuberculosis.

except in cases of gonococcal urethritis, where the diagnosis is obvious from the history of infection and the presence of a discharge. If the blood appears at the end of micturition it must come from the bladder. Typical examples are cystitis or stone (painful), and papilloma or

congested prostate (painless). As the bladder is emptied, its muscular fibres contract down on to the inflamed mucous membrane, on to an ulcerating papilloma or congested prostate, and squeeze blood out of it like water from a sponge.

In the case of a stone, its sharp edges may prick the vesical mucosa during contraction of the bladder, so that a few drops of blood appear at the end of micturition.

If blood is intimately mixed with the urine it may come from the bladder, ureter, or kidney, or may be due to pre-renal causes.

If coming from the bladder, it is produced by an exaggeration of the vesical conditions which give rise to terminal hæmaturia. Thus a papilloma may bleed into the bladder apart from the pressure of the contracting organ and so allow the blood to mix intimately with the urine.

Cystoscopic examination will either reveal an intravesical cause of the hæmaturia or show a normal bladder with blood emerging from one or other ureteric orifice, thus proving its upper urinary tract origin.

PAIN

This may be of three types : vesical, urethral, or prostatic.

Vesical pain is felt in the hypogastrium, and ranges from a feeling of slight suprapubic discomfort to an intense strangury during micturition. It indicates a varying severity of bladder disease which produces an irritated or inflamed mucosa. When combined with difficulty, an obstructive factor, such as stricture or enlarged prostate, is suggested.

Urethral pain or *dysuria* may be terminal or occur during micturition. Pain at the end of micturition referred to the tip of the penis in the region of the frenum, or in the female sex to the labium majus, is diagnostic of disease of the base of the bladder, such as stone, basal cystitis, or malignant growth. An intense scalding in the urethra during micturition is typical of an acute urethritis, but may also occur in phosphaturia or from the passage of gravel. If accompanied by frequency, urgency and strangury, the posterior urethra and the neck of the bladder are also involved.

Prostatic pain is characterised by a sensation of fulness and weight or actual pain in the perineum, and indicates disease of this gland. It may co-exist with urinary symptoms due to obstruction of the bladder neck or cystitis and urethritis. Sacral pain radiating downwards along the back of one or both thighs is suggestive of advanced prostatic carcinoma. In all cases, lower urinary tract pain, of whatever type,

must be viewed in conjunction with other urological symptoms before a provisional diagnosis can be made. Thus, terminal dysuria accompanied by hæmaturia and frequency is suggestive of acute cystitis when pyuria is present, but of a vesical calculus when pyuria is absent.

CHARACTER OF MICTURITION

Five main variations in the character of micturition are commonly observed by the patient: (1) Alteration in the size of the stream. (2) Diminution of the force of projection. (3) Abnormal effects of straining. (4) An intermittent flow. (5) A forked stream.

(1) *An alteration in the size of the stream.* This is characteristic of some form of urethral or bladder-neck obstruction, such as enlargement or fibrous contraction of the prostate, urethral stricture, or stenosis of the external urinary meatus. The reduction in the size of the stream may be of recent onset or may have been in progress for some years.

(2) *The force of projection.* This may be normal though the size of the stream is reduced, or a diminished force of projection may be accompanied by a small stream, the urine falling almost directly to the ground. The former combination is typical of urethral stricture or meatal stenosis and the latter of bladder-neck obstruction.

(3) *Abnormal effects of straining.* Straining may help or hinder the act of micturition. It will help to force urine through a stricture or pin-hole meatus, but in the case of an intravesical projection of the prostate a different state of affairs exists, which will be described under "Difficulty." Straining definitely hinders the act in this case, which can only be initiated after some degree of hesitancy varying from a few seconds to several minutes.

(4) *An intermittent flow.* The flow of urine may be intermittent. This suggests a temporary block, such as can be caused by the sudden impaction of a small calculus in the prostatic urethra, when pain is usually present. A sudden change of position may dislodge the calculus and thus allow the act to be continued. After apparent emptying of the bladder, with relief to the patient, a sudden desire to micturate may occur after a short interval. This passage of urine in two distinct amounts is characteristic of a vesical diverticulum which suddenly empties itself into the bladder after the latter has been relieved of its contents. The first specimen passed may be comparatively clear, the second turbid from stagnation in the diverticulum.

(5) *A forked stream.* The stream may be forked or may emerge in the form of a spray, causing the patient considerable alarm. Such alteration is entirely due to the shape and size of the external urinary meatus and has no surgical significance.

DIFFICULTY

Normal micturition depends on three factors: A patent urethra, normal contraction of the detrusors, and normal relaxation of the sphincters.

Difficulty may therefore be due to obstructive or to non-obstructive causes. If accompanied by pain and frequency, a superadded inflammatory factor is usually present, and these and other urinary symptoms must be considered together in order to arrive at an accurate conception of their causal disease.

Routine examination excludes all urethral, most bladder-neck, and some vesical causes. The remainder require special examinations for their diagnosis, such as urethroscopy and cystoscopy.

The table overleaf summarises the chief causes of difficulty and the situations at which they bring about this symptom.

Obstructive Causes. Difficulty which is of bladder origin is due to partial obstruction of the internal urinary meatus, and may be caused by a foreign body, such as a calculus, or by a growth. Pressure on the bladder neck from without, due to a retroverted gravid uterus, a pelvic tumour, or a large vesical diverticulum situated low down between the bladder and rectum, may bring about the same result.

Obstruction in the posterior urethra is mainly due to inflammatory swelling of the prostatic or urethral mucous membrane and to diseases of the prostate gland. Pelvic operations, when followed by disturbances of micturition, more commonly give rise to retention than to difficulty. If the patient strains in an attempt to overcome the difficulty due to prostatic enlargement the increased urinary tension in the bladder tends to force the prostatic lobes together, thereby increasing the degree of obstruction. The prostatic patient soon learns that the best way to initiate the act is to avoid straining and to wait for a short while, when the flow will usually commence. This hesitancy may vary from a few seconds to several minutes. When a functional cause is superimposed, the turning on of a tap, the holding of one hand in cold running water, or the certainty of privacy may aid the act of micturition. At times these simpler measures fail, and difficulty is replaced by retention, necessitating the appropriate treatment for this condition.

Difficulty from anterior urethral causes is most commonly due to stricture (when a past history of gonorrhœa can usually be obtained), to meatal stenosis, or to phimosis. Meatal stenosis and phimosis can be excluded by inspection.

TABLE

OBSTRUCTIVE CAUSES OF DIFFICULTY OR RETENTION

Bladder.	{	Calculus or foreign body.
		Pedunculated growth.
		Blood clot.
		Diverticulum.
		Pregnancy, especially a retroverted gravid uterus.
		Uterine fibroids or other growth.
		Retroverted uterus.
Bladder neck and posterior urethra.	{	Contraction of internal sphincter (cf. Congenital hypertrophic pyloric stenosis).
		Reflex spasm of sphincters following pelvic or rectal operations.
		Acute posterior urethritis, causing œdema, spasm or both.
		Congenital valves in the male posterior urethra or the female bladder neck.
		Calculus, foreign body or blood clot.
		Cystocele, chronic trigonitis, and urethritis in females.
		Prostatitis (acute and chronic), prostatic abscess, calculi, cysts.
		Prostatic tuberculosis.
		Prostatic enlargement.
		Fibrous prostate.
(Difficulty usually increased by straining.)	{	Prostatic bars.
		Carcinoma or sarcoma of prostate.
	{	Stricture, or congestion superimposed on stricture.
		Peri-urethral abscess or fistula.
		Rupture.
		Calculus, foreign body or blood clot.
		Malignant growths, papillomata, and cysts.
		Phimosis.
		Pin-hole meatus.
		Priapism.
		Spinal cord lesion (fracture, tumour, myelitis).
		Reflex (posterior urethritis, phimosis, anal fissure).
		Thrombosis of corpora cavernosa.

NON-OBSTRUCTIVE CAUSES

Functional: Inability to pass water in the presence of others.

Congestive: Holding water too long, as in a train or car.

Vesical atony: Old people.

Nervous diseases: {
 Tabes.
 Myelitis.
 Multiple sclerosis.
 Spina bifida.

Non-Obstructive Causes. Difficulty due to functional or congestive causes is common, and is often experienced if micturition is attempted in the presence of other people, or after a long journey by car or train.

RETENTION AND SUPPRESSION

Inability to pass water may be due to two causes : (i) Suppression : There is no urine in the bladder because the kidneys have stopped secreting. (ii) Retention : The bladder is full but the patient is quite incapable of emptying it.

Suppression of Urine. This may be complete—anuria, or the amount of urine secreted by the kidneys may be diminished—oliguria. If the condition persists, uræmia, coma and death are the inevitable results. The causes of anuria and oliguria are the same, the former being merely a further stage of the latter. They may be tabulated as follows :

TABLE (after Thomson-Walker)

CAUSES OF SUPPRESSION

- (A) *Hysterical.*
- (B) *Vascular.*
- (C) *Reflex* from urethra, bladder, ureter or kidney.
- (D) *Infective* : (i) Hæmatogenous.
(ii) Urinary.
- (E) *Urinary Tension* : (i) Obstruction, gradual or sudden.
(ii) Sudden relief of obstruction.
- (F) *Removal or destruction of renal tissue.*

(A) *Hysterical.* This may last for some hours or even days. It is followed by polyuria, and never produces symptoms of uræmia.

(B) *Vascular.* This may be seen in cases of shock following severe and prolonged operations, especially if there has been much loss of blood. Anæsthesia or absorption of antiseptics may be contributory factors. If the kidneys are healthy, recovery is the rule, but if diseased, suppression may give rise to uræmia and death.

(C) *Reflex.* This may very rarely follow instrumentation of the urethra or bladder. As a rule there is also some degree of septic absorption due to the passage of infected urine over the damaged area, which is a more likely cause of anuria. Suppression, however, has been

known to occur in the presence of an undamaged mucous membrane and sterile urine.

Operations on the bladder, catheterisation of ureters, the presence of a ureteric or renal calculus, pyelonephritis and movable kidney have all, in rare cases, been followed by anuria.

(D) *Infective.* (i) *Hæmatogenous.* Suppression may be a complication of an acute nephritis, occurring in the course of such conditions as septicaemia, influenza, pneumonia, typhoid and scarlet fever, or gastro-intestinal infection, the organisms being conveyed to the kidneys via the blood stream.

Septic absorption following urethral operations or instrumentation may give rise to anuria in this way.

(ii) *Ascending.* Infection from the lower urinary tract may ascend to the kidneys, setting up a septic pyelonephritis, which in some cases may produce oliguria or anuria.

(E) *Urinary Tension.* (i) *Obstruction.* The inadvertent ligation of both ureters during a hysterectomy will, of course, produce complete suppression. Involvement of the ureters by a malignant growth of the uterus will gradually bring about the same result. Obstruction of one ureter by a stone may cause suppression of urine if the opposite kidney is diseased (calculous anuria).

(ii) *Sudden relief of obstruction.* If an over-distended bladder resulting from prostatic obstruction or urethral stricture is suddenly emptied by catheterisation or suprapubic cystotomy, anuria is likely to occur from sudden engorgement of the renal vessels, which rupture, bleed into, and completely block the renal tubules.

In a large number of such cases the suppression is permanent and the death of the patient inevitable.

It cannot be too strongly emphasized that more than 15 oz. of urine should never be removed from the bladder at any one time.

(F) *Removal or destruction of renal tissue.* Removal of one kidney when the opposite one is absent or diseased is an accident which is a thing of the past when modern methods of investigation are employed, but instances of this have been known to occur, and were naturally followed by anuria and death.

Destruction of renal tissue by disease, e.g. by a tuberculous infection, gradually leads to suppression.

Retention of Urine. Retention is a condition in which the bladder is unable to void its contained urine. In complete or acute retention no urine can be passed at all. In incomplete or chronic retention the patient is able to micturate but there is always some urine left behind in the bladder (residual urine) after the act, which he is unable to pass and which may vary from a few ounces to several pints.

In some cases of chronic retention due to prostatic or urethral obstruction, the patient is apparently incontinent, but this is in reality due to overflow from the distended organ and is known as *false incontinence* (retention overflow).

Retention resembles *difficulty*, and like the latter it may be due to obstructive or to non-obstructive causes. Moreover, the actual causes are identical, and will be found in the table on page 2680.

It is of the utmost importance to distinguish between retention and suppression, and between obstructive and non-obstructive retention.

In suppression there are usually signs of pre-existing disease of the kidneys and absence of disease of the bladder or urethra. Pain does not occur, the bladder is not distended, catheterisation is easy, and no urine is withdrawn.

Retention is usually preceded by a varying period of difficulty and other signs of obstruction. There are no symptoms of renal disease, but the bladder is distended. If due to obstruction, there will be spasmodic attempts to micturate. A catheter will reveal the site of the obstruction. If due to non-obstructive causes, there is, as a rule, no desire to pass water and a catheter passes easily.

The most common causes of acute retention are gonococcal infection in young men, stricture in adults, prostatic obstruction in males over the age of 55, and gynaecological conditions in the female. Its relief, though a matter of absolute urgency, depends to a great extent on its causation, and will be discussed fully under the various diseases which may give rise to this complication.

INCONTINENCE

In young infants incontinence is a normal condition up to the end of the first year, as micturition is entirely a reflex, the centre being situated in the lumbar segment of the spinal cord.

Afferent nerves pass from the bladder and posterior urethra to this centre and are stimulated by distension or irritation of either structure. Efferent nerves are of two kinds which are antagonistic. The

sympathetic fibres pass via the 3rd, 4th and 5th lumbar roots to the inferior mesenteric and hypogastric plexuses, and thence to the bladder. Impulses passing along them cause inhibition of the detrusor (bladder wall) muscles and contraction of the sphincters. The autonomic fibres pass via the nervi erigentes from the 2nd and 3rd sacral roots to the vesical plexus. Impulses through these cause contraction of the detrusors and relaxation of the sphincters.

As the child grows, impulses travelling down the cord from higher centres gradually exert more and more control over this reflex until at about the end of the second year continence is fully established both by day and night.

Incontinence may be of two kinds, false and true. In false incontinence the bladder is full, the escape of urine being merely the overflow from the distended organ. An example of this is the chronic retention with overflow seen in some prostatic or stricture cases.

True incontinence is always associated with an empty bladder and may be of two kinds, active and passive. In active incontinence the contraction of the bladder wall is so powerful that even a normal sphincter is unable to resist the pressure of the urine.

In passive incontinence the sphincter muscles are paralysed and urine dribbles away through the urethra as quickly as it enters the bladder from above.

The following is a brief summary of the more important causes of these various forms of incontinence :

False Incontinence. (Chronic retention with overflow.)

(A) *Obstruction.* (i) Prostatic.

(ii) Urethral, e.g. stricture.

(B) *Nervous disease*, e.g. early tabes dorsalis.

(C) *Nerve injury.* (i) Early stages, about two months following fracture-dislocation, or gunshot injury to spinal cord above level of lumbar micturition centre (Thomson-Walker).

(ii) Lesions of lumbar centre, cauda equina, or hæmorrhoidal sympathetic nerve plexus (e.g. in excision of rectum).

True Incontinence. A. *Active Incontinence.* (Action of sphincters overcome by detrusors.)

Common in children, but rare in adults.

- (A) *Nervous diseases*, e.g. multiple sclerosis causing bladder spasm.
- (B) *Nerve injury*, e.g. later stages (after two months) following fracture-dislocation, or gunshot injury to spinal cord above level of lumbar micturition centre (Thomson-Walker).
Micturition becomes a pure reflex from cutting off controlling impulses from higher centres.
- (C) *Acute inflammations of bladder and posterior urethra*—causing uncontrollable spasm, e.g. tuberculous disease of bladder.
- (D) *Incontinence of childhood*.
 - (i) Physiological (to end of second year).
 - (ii) Where some abnormality can be discovered.
 - (a) Threadworms, anal fissure, vulvitis, phimosis, pin-hole meatus, balanitis, etc.
 - (b) Enlarged tonsils and adenoids.
 - (c) Phosphaturia, oxaluria, uric acid crystals, highly acid urine, bacilluria, cystitis, vesical calculus, etc.
 - (iii) Essential enuresis, where no abnormality within or without the urinary tract can be detected.
- B. *Passive Incontinence*. (Weakness or paralysis of sphincters.)
More frequent in women than men.
 - (i) Weakness of sphincter following parturition.
 - (ii) Cystocele.
 - (iii) Forceible dilatation of female urethra in pre-cystoscopic days, or dilatation of urethra from malignant disease or the impaction of an irregular-shaped calculus.
 - (iv) Sometimes after perineal prostatectomy when the cut urethra is not stitched to the opening in the bladder.

SEXUAL DISTURBANCES

Disturbances of the sexual apparatus include abnormal sexual desire, frequent nocturnal emissions, priapism, impotence, prosta-torrhœa, and testicular pain. In the majority of cases these symptoms are functional, but are occasionally due to some disorder of the genital or lower urinary tract, and should lead to careful investigation and be considered in conjunction with other urinary symptoms. As a rule the lesion, if found, is out of all proportion to the severity of the symptoms with which it is associated. Increased sexual desire with diminished

power of gratification is typical of many cases of enlarged prostate. Various degrees of priapism, often associated with frequency and blood-stained seminal emissions, are frequently seen in acute posterior urethritis, prostatitis, and seminal vesiculitis. Prostatorrhœa is a fairly common symptom, and is usually the result of chronic prostatic congestion or inflammation. It is chiefly noticed after defæcation, which tends to squeeze the secretion out of the prostate and vesicles by the contraction of the abdominal and levatores ani muscles. Impotence may be due to some lesion in the genital tract, such as prostatitis or vesiculitis, to phimosis, or to reflex irritation from an anal fissure or other rectal condition. Testicular pain may be due to small nodules of fibrosis in the globus minor of the epididymis following a gonorrhœal attack. In some cases it is the result of retention of the semen in the blocked tubules of the epididymis. Testicular pain may also accompany a varicocele and renal or ureteral stone. It will be recalled that pain radiating into the testicle is one of the typical symptoms of renal colic.

ALTERATIONS IN THE CHARACTER OF URINE

Cloudiness of the urine as observed by the patient in a chamber or other receptacle may be due to three causes: (1) Cloudiness which appears on standing and which disappears on boiling. This is due to urates. (2) Cloudiness which is increased by heat and which disappears on the addition of acetic acid. This is due to phosphates. (3) Turbidity which fails to clear, either with heat or acid. This is due to pus, indicating inflammation in one or other part of the urinary tract, which may exist alone or complicate a gross lesion, such as stone, stricture or growth. Pyuria necessitates a bacteriological examination of the urine, which must be a catheter specimen in females. The presence of blood in the urine has already been described. An ammoniacal smell may have been noticed by the patient and indicates an alkaline decomposition, such as occurs in the residual urine of prostatic and stricture cases. A fishy smell is characteristic of a bacillus coli infection.

(5a) *Routine Examination of Males.* The importance of a routine examination in the male sex cannot be over-estimated, and is just as necessary whether the symptoms of which the patient complains are referable to the upper or to the lower urinary tract. For this examination no part of the genital tract must be overlooked, as the effects of inflammatory disease may have far-reaching consequences, not only on the various parts of the urinary tract, but on the individual

as a whole. Examples of this are extremely numerous, but it is enough to cite merely a few typical instances: Thickening or enlargement of the epididymis is, in most cases, secondary to disease of the prostate or vesicles. These in turn may be secondary to a urethritis or stricture. Prostatic infection may spread to the bladder and posterior urethra, and experimental work by Winsbury-White has shown that lymphatic spread to the kidney and upper part of the ureter can occur from a prostatitis, which may thus be an aetiological factor in the incidence of such conditions as hydronephrosis and renal stone.

The act of micturition, its frequency, and the examination of the urine may all furnish important information as to the state of affairs in the bladder or upper urinary tract and, at times, lead to the discovery of some general disease, such as diabetes or purpura.

Abdominal examination will give evidence of any palpable abnormality or tenderness of the kidney or bladder, and a general examination may reveal evidence of renal failure or diseases, such as arteriosclerosis or tabes, which may be giving rise to urinary symptoms.

Routine examination, when carefully and conscientiously carried out, will, in many cases, enable a diagnosis to be made, in which case the special examinations, which will be described later, become either superfluous or merely confirmatory. The following is the order in which this examination should be conducted.

No urine to be passed if possible for two or three hours previously.

- | | |
|--|------------------------|
| (a) Penis, prepuce, and external urinary meatus. | } Standing position. |
| (b) Scrotum and its contents. | |
| (c) Rectal examination. | } Knee-elbow position. |
| (d) Act of micturition and examination of urine. | |
| (e) Administration of local anæsthetic. | } Lying. |
| (f) Abdominal examination : | |
| (i) renal areas. | |
| (ii) bladder area. | |
| (g) General examination : | |
| (i) for signs of renal failure. | |
| (ii) for other diseases with urological symptoms. | |
| (iii) for secondary deposits. | |
| (iv) for evidence of nervous diseases, e.g. tabes. | |
| (h) Catheterisation and residual urine. | |

(a) *Penis, prepuce, and external urinary meatus.* The penis is examined for obvious deformity, such as hypospadias, and after retracting the prepuce the glans is examined for signs of a primary syphilitic sore or malignant growth, any difficulty in retraction, indicating phimosis, being noted. The external urinary meatus is examined, and the size of its opening observed, together with the presence of any purulent or mucous discharge, the urethra being squeezed in order to render this more apparent. If discharge is present, a smear must be taken and examined microscopically to identify the causal organism. It is important that no urine should have been passed for several hours before examination, otherwise a slight discharge would be washed away and so pass unnoticed.

In children a pin-hole meatus or tight phimosis is frequently responsible for infection of the lower urinary tract, and this fact should not be overlooked.

(b) *The scrotum and its contents.* The general condition of the scrotum is noted, especially the character of the overlying skin. If a swelling is present, it may be either a hernia, hydrocele, haematocoele, varicocele, or a solid enlargement of the testis. The cord immediately below the external ring is grasped between the fingers and thumb, the patient being in the erect position. If this is normal and the fingers meet above the swelling, a hernia is definitely excluded. Should this be impossible a hernia or diffuse hydrocele of the cord may be present. A hernia is often reducible, has an impulse on coughing, and is rounded in outline, while a hydrocele is semi-fluctuating, irreducible and sausage-shaped. If the swelling is purely of scrotal origin, a varicocele can be diagnosed by its worm-like feel, its disappearance on lying down and its reappearance by filling from below on standing up. If the swelling is rounded it must be decided whether it is solid or fluid. If fluid, it is either a hydrocele or an early haematocoele. The former is translucent, the latter non-translucent, having a history of sudden onset. If a hydrocele is present, no opinion can be given as to whether it is primary or secondary until the body of the testis has been palpated. The latter should lie in the lower and posterior part of the swelling, but cannot always be felt until fluid is first removed by tapping. In the presence of an encysted hydrocele of the epididymis or cord, the testicle can be identified apart from the main swelling.

A solid enlargement of the scrotum is either a haematocoele or is due to inflammation, syphilitic, tuberculous, or neoplastic disease of the testis. A haematocoele may sometimes be diagnosed by the history and

the fact that the centre of the swelling is fluid while the surrounding parts are hard. Enlargement of the epididymis, while the body remains normal, is due either to tuberculous disease or to epididymitis of inflammatory origin. If tuberculous, it is nodular, the cord is frequently beaded, a secondary hydrocele is uncommon, testicular sensation is present and, in the later stages, adhesion to, or ulceration through, the posterior aspect of the scrotum is observed. Other evidences of tuberculous disease will be found as the routine examination progresses. Enlargement of the testis proper without involvement of the epididymis may be due to chronic orchitis or syphilis. The syphilitic testicle is usually very hard and smooth, without testicular sensation and, as a rule, accompanied by a secondary hydrocele. In the later stages, adhesion to, or ulceration through, the anterior aspect of the scrotum may occur with formation of a typical gummatous ulcer. A history of syphilis may have been obtained, and the Wassermann found to be positive. A distinctly heavy swelling involving both epididymis and testicle, with an absence of testicular sensation and with involvement of the structures of the cord, is most likely due to a malignant growth. These scrotal findings must, of course, be assessed in conjunction with the history, symptoms, and other details of the routine examination.

(c) *Rectal examination.* Examination of the rectum should always be made in the knee-elbow position. The examining finger, protected by a finger-stall or glove which is well vaselined, is gently passed through the anus, the patient being asked to strain down. The prostate is easily felt bulging into the anterior wall of the rectum. Hæmorrhoids, fistula and fissure, if present, are noted. The normal prostate is rounded and firm to the touch. A shallow, median, longitudinal groove and sharply demarcated lateral borders are characteristic features. The amount of projection of the prostate into the rectum can be readily assessed by a circular sweep of the finger around these borders, though it must be borne in mind that an intravesical enlargement of the prostate or fibrous degeneration may be present without increase of the rectal projection. By passing the finger onwards, the upper margin of the prostate can be felt, and beyond this are situated the two vasa deferentia and seminal vesicles, which are not palpable unless inflammatory induration has occurred. The ureters are inserted into the bladder on either side of the mid-line, above and to the outer sides of the prostate, but can only be felt if they contain a stone or if thickening due to peri-ureteritis is present. Between the two ureters and beyond the seminal vesicles the soft bladder base

can be palpated and thickening in this area may be one of the signs of a malignant vesical growth.

A properly conducted rectal examination will thus give information as to the size, shape and consistency of the prostate, and will reveal any abnormality of the gland, such as irregular thickening due to abscess or stone formation, and invasion of the rectal wall or surrounding structures by malignant disease. Inflammatory infections of the prostate and vesicles can be palpated and an indication of their severity obtained by the amount of accompanying discomfort or pain.

Rectal examination should be concluded with prostatic and vesicular massage which expresses the contents of these organs into the posterior urethra.

(d) *Act of micturition and urine.* The patient is directed to pass his water into two glasses. The act should be observed, so that any lower urinary tract symptoms may be verified, for example, difficulty in starting, whether straining helps or hinders, the size of the stream, its force of projection, and whether there is accompanying pain. If the patient's difficulty is eased by straining, obstruction due to stricture is suggested. If straining causes increased difficulty it is usually the result of bladder-neck obstruction, such as an enlarged prostate.

The first glass of urine will contain the contents of the prostate and vesicles, some degree of opalescence being normal. The presence of threads or turbidity not clearing with heat or acid suggests infection in these organs.

The second glass should contain clear urine if the bladder is normal. Turbidity, not clearing with acid, proves that infection is also present in the bladder.

(e) *Administration of local anæsthetic.* Efficient local anæsthesia of the male urethra is perhaps the most useful aid to urology and is an essential preliminary to all forms of instrumentation. It must be remembered that the lower urinary tract is extremely sensitive, and this is one of the reasons why patients hesitate in presenting themselves for examination. By means of local anæsthesia all the routine instrumental procedures can be rendered painless, but it is not generally realised that this can only be done by using cocaine hydrochloride, and by introducing it in the manner about to be described.

It is true that this drug has been viewed with disfavour by a large number of urologists because, when used alone, a strength of at least

2 per cent is required to produce efficient anæsthesia, and this in the urethra may give rise to dangerous toxic effects. If, however, sodium bicarbonate is added to cocaine hydrochloride, the anæsthetic action of the latter is increased at least sixfold according to the following reaction :

Cocaine hydrochloride + sodium bicarbonate \rightarrow Cocaine bicarbonate + sodium chloride.

Cocaine bicarbonate readily dissociates into its component radicles, i.e. cocaine and bicarbonate, whereas cocaine hydrochloride does not, and thus the cocaine radicle is set free and its effects on the urethral nerve endings is much increased.

After experimenting with various concentrations it was found that a 0.5 per cent solution of cocaine hydrochloride when mixed with 0.5 per cent sodium bicarbonate gave perfect anæsthetic results without the slightest risk of toxic symptoms. To this mixture is added 0.25 per cent chloretone, which acts partly as a mild anæsthetic but mainly as a preservative. The actual formula is as follows :

Cocaine hydrochloride	3 grs.
Sodium bicarbonate	3 grs.
Chloretone	1½ grs.
Distilled water to	1¼ oz.

Once the solution is made up it should be used within twenty-four hours, as it gradually loses its anæsthetic effect. A convenient way of ensuring a fresh supply is to have a stock solution of 0.5 per cent sodium bicarbonate in chloretone water and some packets of cocaine hydrochloride each containing 3 grains. One packet is dissolved in 1¼ oz. of solution when required.

Method of Introducing the Local Anæsthetic. (i) The patient's bladder should be empty, if possible, as this prevents dilution of the solution in the posterior urethra with consequent diminution of its anæsthetic effect in the very place where it is most required.

(ii) The patient is placed on his back on a couch, and the penis, with retracted prepuce, is well washed with warm boracic lotion and isolated by towels.

(iii) Traction is made on the penis, which is held behind the glans with the middle and ring fingers of the left hand, the thumb and forefinger holding the lips of the meatus apart.

(iv) Two drachms of solution are injected into the anterior urethra with a urethral syringe (fig. 1482), and retained by placing a penile clip (fig. 1483) on the glans.

(v) After three minutes the penis is again held and the urethra compressed by the second and third fingers of the left hand to prevent escape of the anæsthetic, the penile clip is removed, and a further two drachms injected which force the first two drachms back into the posterior urethra. The penile clip is then reapplied.



Fig. 1482.—URETHRAL SYRINGE.

(vi) Two more amounts of two drachms each are injected at three-minute intervals, after which the patient is ready for instrumentation. (vii) In some cases of stricture it will be found that the urethra will not hold two drachms, in which case smaller amounts will have to be injected up to a total of one ounce.

The time occupied by the administration of the anæsthetic solution should be employed in making such general and abdominal examinations as may be suggested by the symptoms and history of the patient.

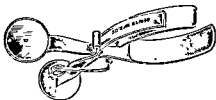


Fig. 1483.—PENILE CLIP.

(f) *Abdominal examination.* This examination is directed especially to the loins and hypogastrium in order to obtain all possible information about the kidneys, ureters and bladder. A distended bladder may readily be seen as an oval swelling rising from the pubes towards the umbilicus. It can be palpated easily by placing the hands on either side of the recti muscles. The swelling is elastic and dull on percussion, and pressure often produces a desire to micturate. Distension of the bladder is a most important sign and should always be sought before catheterisation or cystoscopy is performed.

A kidney, which is either sufficiently large or mobile to be palpated, can be readily felt bimanually when one hand is placed in front of and the other behind the loin. Unless grossly distorted by disease it is of typical shape and can be made to move between the two hands in a

characteristic manner. It moves freely with respiration and has some degree of mobility from side to side. It is dull to percussion, and has a band of resonance separating it from the liver. On the right side a renal swelling must be distinguished from a distended gall-bladder, a Riedel's lobe of the liver, a tumour of the colon, and sometimes from an ovarian cyst; on the left side from an enlarged spleen. Distension of the gall-bladder presents a tumour which is usually pyriform in shape and which cannot be pushed back into the loin. Its dullness is continuous with that of the liver. Riedel's lobe presents similar characteristics. Colonic carcinoma is, as a rule, more mobile from side to side, while the movements of an ovarian cyst are limited above by its pedicle, though downward and lateral mobility is present. On the left side an enlarged spleen can usually be distinguished by its downward and inward enlargement towards the umbilicus, its superficial position, and the presence of a notch in its anterior border. Special notice should be taken of any tenderness over the kidney or ureter, and a comparison must be made with the opposite side.

(g) *General Examination.*

- (i) For signs of uræmia.
- (ii) For other diseases with urological symptoms.
- (iii) For secondary deposits.
- (iv) For evidence of nervous diseases, e.g. tabes.

(i) *Signs of uræmia.* The tongue is dry, at first along the centre and later over the whole surface, and becomes red, glazed and cracked. In the later stages it is covered with a brown, dry fur. The skin is dry and harsh, and in the late stages the face has a peculiar yellow earthy appearance. Emaciation is often present. The temperature is sub-normal in practically all aseptic cases and in chronic septic pyelonephritis. Dyspnœa may be present and the breath have an ammoniacal smell. A combination of hissing dyspnœa in a drowsy patient with bleeding gums is very suggestive of uræmia (Bradford). Cheyne-Stokes breathing may occur. Hiccough, vomiting, and diarrhœa are not infrequent. Drowsiness, coma, convulsions, and other nervous signs are observed in acute uræmia and in the terminal stages of sub-acute and chronic uræmia. The stuporous patient is occasionally very restless.

(ii) *Other diseases with urological symptoms.* In cases of hæmaturia the heart should always be examined for the murmurs of *mitral stenosis*. Since emboli also occur in cases of *sub-acute bacterial endocarditis*, the

signs of this disease, viz. fever, variable cardiac murmurs, clubbing of the fingers, petechiæ and Osler's nodes, should be sought. The scanty albuminous urine, rich in urates, in cases of *congestive heart failure*, should lead to examination for enlargement of the liver, œdema and signs of a cardiac lesion. Hæmaturia also occurs in *purpura*, of which the chief signs are cutaneous petechiæ, and in certain cases epistaxis and hæmorrhages from mucous membranes. *Scurvy* is another cause of hæmaturia, and is recognised by tenderness of the bones, swollen bleeding gums, anæmia and, in infants, palatal hæmorrhages. Polyuria occurs in various conditions—*diabetes mellitus* and *insipidus*, *lardaceous disease*, *hysteria*, etc., which are easily differentiated if kept in mind. The odour of the breath may indicate that a *drug* or *poison* causing hæmaturia, e.g. turpentine, has been taken. Peculiar coloured urines demand general and chemical examinations to determine their causes. In cases of hæmoglobinuria the clinician should look for white or blue fingers (as in *Raynaud's disease*) and for signs of *syphtis*; also for the signs of *acute hæmolytic anæmia* (fever, jaundice, etc.). Black urine always suggests the presence of *melanotic sarcoma*, of which the primary focus is in the skin or eye, the secondary growths being palpable in the liver. The urine may blacken only on standing. Dark green urine occurs in *alkaptonuria*; in this condition the sclerotics and pinæ may be dark (ochronosis), and the linen is stained brown. Bile in the urine, and drugs which alter the colour of the urine—e.g. methylene blue in certain kidney pills—do not require special comment. Gas in the urine sometimes occurs in *diabetes mellitus*, and also in *vesico-intestinal fistula*. Milky urine is found in cases of *filariasis*; in these cases of *renal tuberculosis* signs of pulmonary tuberculosis disease may be found, and should always be sought.

Typhoid fever may sometimes have an onset resembling nephritis with blood in the urine. It is possible for an *inflamed appendix* adherent to the ureter to cause urinary symptoms, such as hæmaturia, but this is an extremely rare occurrence; more frequently, perhaps, adhesion to the bladder causes irritability of this organ. Frequency of micturition occurs very rarely as a symptom of *cholecystitis*.

(iii) *Secondary deposits from malignant disease of the urinary organs*, e.g. kidney, bladder, prostate and testicles. *Embryonoma* of the kidney may be accompanied by secondary growths in lungs, bones or brain; even the spleen may be the seat of a metastasis. *Prostatic cancer* is notorious for its tendency to deposit in bones, particularly the pelvis

and vertebræ. Secondary deposits from *testicular growths* most commonly involve the lumbar glands.

(iv) *Signs of nervous diseases.* Incontinence of urine and indecent behaviour occur in some cases of *lesion of the frontal lobe* of the brain. Retention and overflow are frequent in *tabes dorsalis*, of which disease Argyll-Robertson pupils, Achilles analgesia, and loss of ankle-jerk and knee-jerk are the cardinal signs; Romberg's sign is often elicited, and the gait may be ataxic. Urgency and other disturbances of micturition occur in cases of *disseminated sclerosis*, of which the early signs may be any of the following: A central scotoma in the visual field, nystagmus, absent abdominal reflexes, or extensor plantar reflexes; there is usually no sensory loss. *Lesions of the cauda equina* are very apt to cause both bladder and rectal symptoms. The chief signs are an area of anæsthesia round the anus and over the buttocks and external genitalia, and loss of the bulbo-cavernosus and anal reflexes and of the ankle-jerks.

(h) *Catheterisation and residual urine.* The passage of a catheter will at once determine the presence or absence of a stricture, which should be dealt with as described on page 3077.

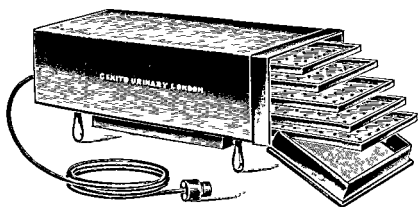


Fig. 1484.—FORMALIN CABINET FOR CATHETERS.

Any obstruction encountered proximal to this must be due to contraction of the bladder neck, as in some cases of chronic prostatitis and fibrous prostate, or to distortion of the posterior urethra from the intravesical projection of an enlarged gland. Both these types of obstruction will be described in detail under their appropriate headings, and thus only general directions for the passage of a catheter need be given here.

The best gum elastic catheters are made by Eynard in a variety of shapes and sizes. They are sterilised by boiling and then transferred

to cabinets containing formalin (fig. 1484), in which the tablets are heated by electricity; the catheters are thus always ready for immediate use.

The more useful shapes of catheters are:

Coudé catheters (fig. 1485), bicond catheters (fig. 1486), olivary-headed catheters (fig. 1487), catheter followers and guides (fig. 1488), rubber catheters (fig. 1489), and metal catheters with stylette (fig. 1490). The sizes of catheters range from No. 4° to 30° Charrière, although the smallest and largest sizes are rarely used. The numbers of the Charrière, or French, scale denote the external circumferential measurement in millimetres, and it will be convenient here to compare this with the English and some others less commonly used (fig. 1491).

The Beniqué, another French scale, is twice the Charrière. Thus 20° Charrière is equal to 40° Beniqué. This scale is often used in connection with ureteric catheters and some makes of Kollmann dilators. The American scale is two-thirds of the Charrière, 20° American being equal to 30° Charrière.

The English scale is two divisions less than the American, 12° English being the same as 14° American.

These four scales can be summarised as follows:

Beniqué scale of 42°

=Charrière scale of 21° (= circumference in mm.).

=American scale of 14° ($\frac{2}{3}$ of Charrière).

=English scale of 12° (2 less than the American).

A sterile coudé catheter of 21° Charrière calibre is selected and lubricated with lubafax. The penile clip is removed from the glans, the penis held by the second and third fingers of the left hand behind the corona glandis, and some degree of traction is made on the organ. The catheter is inserted into the meatus, keeping the beak turned towards the patient, and gently passed down the anterior urethra. A slight resistance is encountered at the membranous portion, but a little extra pressure is enough to overcome this, when it will be found to slip through the posterior urethra into the bladder, its entrance being heralded in normal cases by the appearance of approximately 1 oz. of liquid anæsthetic. Any increase over 1 oz. should be carefully measured as this indicates the amount of residual urine.

Should difficulty be encountered at the bladder neck, smaller sizes of coudé catheters must be tried, and should they fail, a bicond, or even a curved metal catheter, will be useful in obvious prostatic cases. In



Fig. 1485.—COUDÉ CATHETER.

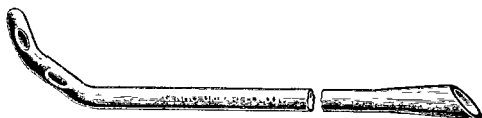


Fig. 1486.—BICOUDÉ CATHETER.



Fig. 1487.—OLIVARY-HEADED CATHETER.



Fig. 1488.—CATHETER FOLLOWER AND GUIDE.



Fig. 1489.—RUBBER CATHETER.



Fig. 1490.—METAL CATHETER WITH STYLET.

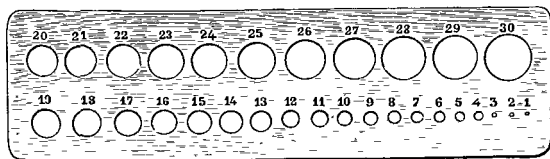


Fig. 1491.—CATHETER GAUGE.

the presence of chronic prostatitis or fibrous prostate an olive-headed catheter is more likely to succeed.

Residual Urine. The estimation of this constitutes one of the most important parts of the whole investigation, and without it exact diagnosis and correct treatment are impossible. Stenosis of the bladder neck is a common sequel of chronic genital infection, and investigations show that this obstruction is almost as common as that due to enlargement of the prostate, both types being responsible for the presence of residual urine.

(5b) *Routine Examination of Females.* Routine examination in the female sex is just as important as it is in the male, and should always be carried out when investigating upper or lower urinary tract symptoms. Disturbances of micturition are far more common before the age of sixty in women than in men, and the causes for this must undoubtedly be looked for in some part of the genital tract. The most important gynaecological abnormality giving rise to urological symptoms is undoubtedly chronic cervicitis. Winsbury-White, by injecting the cervixes of rabbits, rats and guinea-pigs with Indian ink and tubercle bacilli, has demonstrated lymphatic spread, both forwards into the sub-trigonal region of the bladder, and upwards to the hilum of each kidney via the lymphatics running along the posterior abdominal wall. He believes that such genital infections are important factors in the ætiology, not only of the frequency, dysuria, and backache so common in women, but also of upper urinary conditions, such as hydronephrosis and renal calculus. Examination is conducted in the lithotomy position, the patient being placed on a cystoscopic couch with the thighs widely separated. The observer sits on a stool and focusses a good headlight on the perineum. The following is the order in which this routine examination should be carried out:

- (a) Urethra (smears if necessary).
 - (b) Catheterisation and collection of a catheter specimen from the bladder.
 - (c) Inspection of the genital tract through a bivalve speculum (smears if necessary).
 - (d) Bimanual examination.
 - (e) Abdominal examination.
 - (f) General examination.
- As for males. { (See page 2692.)

(a) *Urethra.* The urethra is first examined for signs of acute or chronic urethritis, remembering that the latter is responsible for many cases of cystitis. If discharge can be seen, a smear should be taken and examined bacteriologically to determine the nature of the infecting organism. In suspicious cases, but where no discharge is present, it is well to pass a finger into the vagina and "milk" the urethra forward, thereby emptying the urethral glands of their contents, often with the appearance of discharge at the meatus. A caruncle or carunculoid degeneration of the urethra, or prolapse of its mucous membrane, may be noted.

(b) *Catheterisation and collection of catheter specimen.* A small glass catheter is passed into the urethra, any obstruction, suggesting chronic urethritis or stricture, or pain during its passage being observed. A No. 12 English size should pass easily without causing discomfort or bleeding. The catheter specimen should be examined for obvious signs of infection and, if necessary, a small quantity poured into a test-tube and acetic acid added. If the urine fails to clear, the remainder of the specimen should be examined bacteriologically.

(c) *Examination of genital tract.* The condition of the vulva should be noted and special attention paid to the presence of inflammation or of a Bartholin's cyst. In children signs of vulvitis should be specially looked for. The patient should be asked to strain, which will accentuate a cystocele, rectocele, or uterine prolapse if present. A bivalve speculum (fig. 1492), warmed and lubricated, is passed into the vagina and the cervix brought into view. Any degree of displacement and alteration of the direction in which the cervical canal is pointing is observed. After drying the external os with pledgets of cotton wool grasped in a pair of alligator forceps (fig. 1493), or twisted on a Playfair probe, a search is made for cervical discharge, cervical erosion,

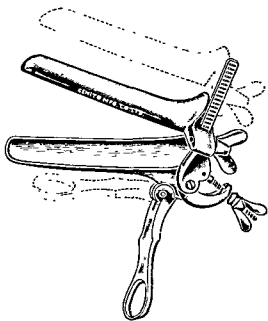


Fig. 1492.—BIVALVE SPECULUM.

the presence of a tear, or signs of acute or chronic cervicitis. If a discharge other than mucoid is present, a smear should be taken and examined bacteriologically. Gonococcal infection in the female is frequently unsuspected and may only be diagnosed by this means. As

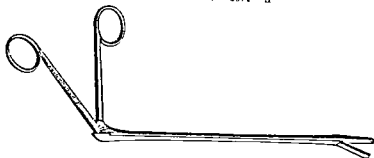


Fig. 1493.—Alligator Forceps.

has been stressed, the presence of inflammation in this situation is frequently the cause of urinary tract disturbances, which will only clear up when this focus of infection is cured.

(d) *Bimanual examination.* One or two fingers, protected by a glove or finger-stalls, are inserted into the vagina while the other hand is placed on the lower abdomen. The size, shape, and position of the uterus is determined and, if possible, the condition of the tubes and ovaries ascertained. Any tenderness in the fornices is noted, and the examination should reveal any abnormality of the reproductive apparatus and pelvic floor, such as uterine displacements, tubal inflammatory conditions, fibroids, ovarian tumours, etc. Sometimes thickening of, or stone in, the ureter can be palpated in this way.

(e) and (f) *Abdominal and general examinations.* These are carried out in the same way as for males, and their nature depends on the symptoms and history of the patient.

SPECIAL EXAMINATIONS

Special urological examinations become necessary: (1) When routine examination is not sufficient to determine the diagnosis. (2) When confirmation is required for a provisional diagnosis made by simpler means. (3) When exact information is required about the condition of the rest of the urinary tract. (4) To determine the functional capacity of one or both kidneys before urinary operations or instrumentations are carried out.

The following is a list of the special procedures in common use at the present time, which consist of chemical, bacteriological, instrumental and radiological examinations, or a combination of two or more of these :

- (a) Chemistry, cytology, bacteriology, and animal inoculation of urine.
- (b) Anterior urethroscopy.
- (c) Posterior urethroscopy.
- (d) Cystoscopy and chromo-cystoscopy.
- (e) Ureteric catheterisation and collection of urine from each kidney.
- (f) Plain X-ray.
- (g) X-ray and opaque ureteric catheter.
- (h) Intravenous pyelogram.
- (i) Ascending pyelogram.
- (j) Renal function tests.

(a) *Chemistry, Cytology, Bacteriology, and Animal Inoculation of Urine.* (By Dr. F. A. Knott.) In order to obtain accurate information regarding a specimen of urine, it is essential for it to be obtained by catheterisation in the female, though in the male careful washing and drying of the penis before micturition is sufficient.

(i) *Chemical Examination.* Under this heading the following facts are elicited : Colour, specific gravity, reaction, the presence of protein, sugar, blood, bile, urobilin, foreign pigments, and inorganic deposits such as urates and phosphates.

Reaction. In the treatment of urological cases it is often necessary to determine the reaction rather more accurately than is possible with litmus paper. For this purpose a few drops of bromo-thymol blue, an indicator with a pH range of 6.0 to 7.6, and changing from yellow to blue, may be added to the freshly passed urine. By judging the colour tint produced, a very good idea of the exact reaction (H.ion concentration) can be obtained.

Colour and specific gravity. Paleness is usually due to lack of concentration. If the patient's diet and fluid intake are normal, a persistently diminished colour may indicate the necessity for investigation by one of the renal function tests described on page 2747. Increased

colour usually arises from excess of normal pigment and concentration, but may come from foreign pigments from (a) the blood stream, i.e. bile-pigments, blood-pigments, melanin or indican; or (b) excretion of drugs and dyes, particularly iodides, bromides, salicylates, rhubarb, senna and phenolphthalein. All these are readily detected by the tests described in standard works of clinical pathology.

Protein. The best test for albumen is to take in a hard glass test-tube the supernatant fluid after centrifuging the urine preparatory to the cytological examination of the deposit, and to add a few drops of bromo-thymol blue. If the reaction be alkaline (blue colour) add acetic acid drop by drop until it is just acid (yellow). Boil the top of the column of urine, and if a cloud forms add a drop more acetic acid and heat again. If the cloud persists, protein is present. Remember that the presence of protein does not necessarily imply renal damage and leakage of protein through the kidney. Any albuminous material, e.g. blood, pus, or epithelial cells derived from the various possible sources, produces a positive test for protein. Orthostatic albuminuria may sometimes have to be considered, or when the cloud redissolves on boiling, that rare condition—Bence-Jones proteosuria, which is seen in cases of myelomata. But in any case, the important point is that if protein is found in the urine its presence must be explained and the patient thoroughly examined.

Blood. Spectroscopic and microscopic examinations will detect this readily, and as in the case of protein it must be accounted for. The various possibilities are detailed later in this chapter.

Sugar. Probably the best and most reliable test is Benedict's, the only serious fallacy of which is that, in women, the urine may contain lactose during lactation, but this possibility is always clinically obvious. If glucose itself is found when the patient is on a normal diet, a decision has to be made between renal glycosuria and some form of true diabetes. A glucose tolerance test will decide this. The fasting patient is given 50 grams of glucose by mouth and the blood sugar estimated at intervals up to at least two hours. In true diabetes it is always wise to test also for acetone (Rother's test) and diacetic acid (ferric chloride test), and thus obtain indication of acidosis if it is present.

Inorganic deposits. The important points in this connection are described under the paragraphs concerning cytology.

Bile-pigments and bile-salts. Tests are made by the usual methods, of which a simple one for the former is to float a ring of diluted tincture

of iodine upon an equal volume of urine; a green ring indicates bile-pigments. For bile-salts, Hay's sulphur test is still the most reliable. A little fine sulphur powder is sprinkled upon the surface of the urine. In the presence of bile-salts, the lowered surface tension allows the sulphur to fall to the bottom; in normal urine it floats.

Urobilin. This is best tested for spectroscopically with the urine acidified, the absorption spectrum being typical.

Indican can be demonstrated by Jaffé's test, which requires that two inches of urine in a test-tube be treated with a little concentrated hydrochloric acid, followed by 2-3 cc. of chloroform. A single drop of 2 per cent potass. chlorate is added, the whole mixed, and then allowed to separate on standing. A blue colour (indigo), which is taken up by the chloroform and is not destroyed by sod. thiosulphate, is a measure of the indican present.

(ii) *Cytological Examination.* This is carried out to establish the possible presence of pus cells, red blood-corpuscles, casts, epithelial cells, tumour cells, and crystals. Before the cytology can be discussed, it is essential that the normal appearances should be appreciated. After centrifuging, an ordinary specimen from the male, or a catheter specimen from the female, may contain very occasional leucocytes and vesical cells, but not more than one to every field of the microscope, using $\frac{1}{8}$ -inch objective; larger numbers should arouse suspicion. In a non-catheter specimen from the female, as a result of the passage of urine over external surfaces, at least ten times as many leucocytes and often a considerable number of squamous cells are present. By chemical tests a trace of albumen may frequently be obtained owing to their presence. It is essential for this reason that only catheter specimens in the female be employed for special urinary examinations. The urine is centrifuged for $\frac{1}{4}$ hour and a small amount of the deposit is mixed with a trace of ordinary methylene blue (the best stain for showing up the nuclei of cells) and examined under a low-power microscope.

Pus cells and red blood-corpuscles. If pus cells or red blood-corpuscles are present the cause must be determined. The former, which are invariably associated with infection which may be primary or secondary, must, if found, lead to the examination of Gram-stained films and cultures in order that the causal organism may be identified. If organisms are absent, and especially if the urine is acid, the possibility of a tuberculous focus must be remembered and Ziehl-Neilsen

stained films should be examined microscopically with the greatest care for tubercle bacilli. When red blood-corpuscles are found it must not be forgotten that their presence may be due to other causes than surgical conditions of the urinary tract. Thus a patient may continue to pass red cells for a very considerable time after an earlier nephritis has, as judged by clinical standards, resolved. A few red cells may be present in the urine in relatively mild degrees in any of the purpuric or toxic states. A number of drugs may have the same effect, and inquiry should be made into any medicinal treatment recently received by the patient. Congenital cystic kidneys and a variety of diseases of the circulatory system may be accompanied by mild degrees of hæmaturia, which emphasises the importance of excluding purely medical causes before a diagnosis of a urinary tract lesion is made.

Casts. It must be remembered that hyaline casts and albumen accompany infections of all kinds, even if only a moderate degree of fever is present. On such occasions they have no significance in so far as the urinary tract is concerned. When the casts contain leucocytes, renal cells, or red cells, their presence implies a pathological renal condition.

Epithelial cells. Epithelial cells found in the urine vary from large squames with a relatively small central nucleus to the small renal pelvic cell of irregular pointed shape with a nucleus occupying a large part of it. Isolated squames, as has been explained, are of no significance, but epithelial debris in any quantity arising from the upper urinary tract may be very suggestive of lesions in this situation, providing that there is no question of their being produced by mild trauma during catheterisation.

Tumour cells. Tumour cells and masses are often described as occurring in the urine of patients who have a growth in the urinary tract, but in actual practice they are very rare, and it is most unsafe to be dogmatic as to their nature until the fragments have been collected, hardened and sectioned in the same way as all surgical material in which the question of neoplasia and malignancy arises.

Crystals. Crystals in the urine are commonly the result of concentration or cooling of the specimen, and their nature is largely governed by the reaction of the urine when it is passed. Identical action is made by microscopy and is simple. It is of the utmost importance to know whether the crystals are present when the urine is passed;

i.e. Is deposition occurring within the urinary tract? For this determination the need for an absolutely fresh specimen is essential. Bacterial decomposition within the urinary tract usually results in extreme alkalinity of the urine with deposition in the bladder of phosphate crystals, the most noticeable form being the large clear "coffin lids" of triple phosphate. Uric acid or oxalate crystals are often found in concentrated acid urines and in the urine of patients suffering from renal calculus. Hexagonal plates of cystine always imply a congenital liability to calculous formation. Intensive alkaline treatment of real or suspected renal lesions and the marked alkalinity of the urine which results produce such immediate deposit of amorphous phosphate, that the examination of the specimen is greatly interfered with; it is a good plan, therefore, to redissolve as much of the phosphate as possible by acidifying the urine with dilute acetic acid before examining for other abnormalities in the deposit.

(iii) *Bacteriological Examination.* A bacteriological examination of the urine has for its object the identification of the organism responsible for or secondary to any urinary lesion present. In some cases of pyrexia of unknown origin, however, although no urinary lesion exists, bacilli or cocci may be present in the urine and their identification will assist in establishing a diagnosis. The following organisms are commonly found when an inflammatory lesion of the urinary tract is present: *Bacillus coli*, *staphylococcus*, *streptococcus*, *bacillus proteus*, and *bacillus pyocyaneus*. As a rule the *bacillus coli* occurs in pure culture although mixed infections may be found. The urine is acid in pure *B. coli* and *streptococcal* cases, but undergoes ammoniacal decomposition if *staphylococci* or *B. proteus* are present. In carrying out a bacteriological examination, the first step is to centrifuge the urine, using a sterilised tube, and from the deposit to make thin Gram-stained films for microscopical inspection of the bacterial types and also to spread a small amount of the deposit over the surface of plates of solid agar culture media so that, after incubation at 37° C., the bacteria present grow as single colonies. From these colonies exact identification of the strains can be made and, when necessary, pure sub-cultures prepared for vaccines.

(iv) *Animal Inoculation.* Inoculation of the centrifuged deposit of a urinary specimen is of the utmost importance in cases of renal tuberculosis. In this condition the organism often cannot be found by direct bacteriological examination. A freshly obtained catheter specimen

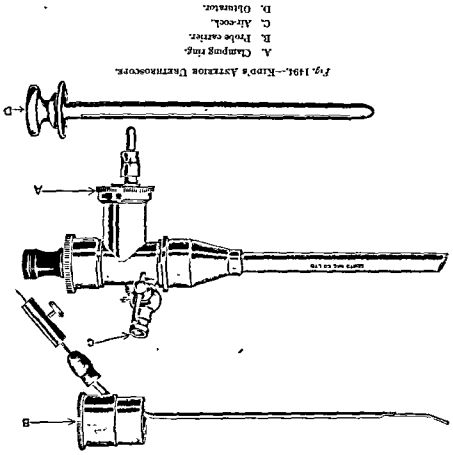


Fig. 1491.—Kidd's Anterior Urethroscope.

- A. Clamping ring.
- B. Probe carrier.
- C. Air-cool.
- D. Obturator.

from either bladder or kidney is centrifuged and the deposit injected into the inguinal glands of a guinea-pig. The animal is killed five or more weeks later and careful macroscopical and microscopical examinations made of the spleen, and of the glands, (a) at the site of inoculation, and (b) throughout the body, for evidence of tuberculous deposits.

(b) *Anterior Urethroscopy.* Anterior urethroscopic examination consists of the passage of the tube of an anterior urethroscope into the male or female urethra for the purpose of inspecting that part of the canal which lies between the external urinary meatus and the sphincter urethrae, situated between the two layers of the triangular ligament. Two main types of instrument are used: In the one, the light is reflected down the tube from a lamp situated at its proximal end, and in the other, a small electric bulb is placed in the lumen of the tube itself at its distal end. The best example of the former type is Kidd's anterior urethroscope (fig. 1491), and of the latter Harrison's (fig. 1495). Anterior urethroscopy is of the utmost importance for complete diagnosis of many urethral diseases, for example, chronic inflammation,

leucoplakia, stricture, congenital malformation, and calculus or foreign body. By its means, diathermy treatment can be applied to infected follicles and innocent new growths, while in some cases it is of help in the passing of a guide through a stricture.

Technique. Males. The patient is directed to pass his water and to lie on his back on a couch. The penis is swabbed with mild disinfectant lotion and isolated by means of a lithotomy towel. The anterior urethra is anaesthetised with cocaine bicarbonate solution, as has been described, but only two successive amounts of 2 drachms each are necessary. After testing the light, the urethrosopic tube, with obturator in position, is lubricated with a small quantity of lubafax and passed gently down the urethra until it reaches the bulb. The obturator is withdrawn and all superfluous moisture and lubricant removed from both the tube and the bulb of the urethra by means of

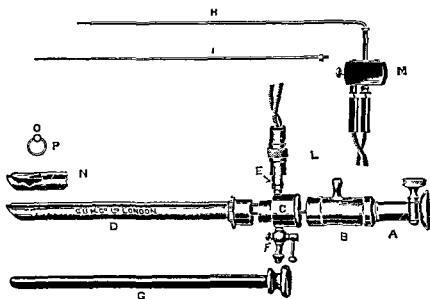


Fig. 1495.—HARRISON'S ANTERIOR URETHROSCOPE.

- A. Eye-piece for operative attachment.
- B. Operative attachment.
- C. Lamp carrier.
- D. Cannula.
- E. Electrical switch.
- F. Bellows attachment.
- G. Obturator.
- H. Electro cautery.
- I. Probe for treating urethral follicles with fused silver nitrate.
- L. Handle.
- M. Handle for electro cautery.
- N. The lamp stem is carried in a special tube in the long side of the cannula, as shown at N.
- O. } Cross-section of side tube carrying lamp.
- P. }

small sterile pledgets of cotton wool inserted with a pair of alligator forceps. The "head" of the urethroscope is next attached, the light switched on, and the tube of the air bellows attached to the air-cock. The bulb of the urethra is carefully examined and inflated with air to enable all parts of its wall to be brought into view. By depressing the instrument the distal aspect of the sphincter urethrae can be examined. The instrument is then gradually withdrawn and all parts of the urethral wall viewed, both when collapsed and when distended with air, until finally the fossa navicularis and external urinary meatus are reached. Special points to be observed in the examination of the anterior urethra include the character of the mucous membrane, the presence of any degree of inflammation, the appearance of Littre's glands which are dotted freely on the roof, sides and floor of the canal, and of the lacunae of Morgagni which are found on the roof only. These glands, when unaffected by disease, are rarely visible, but are of extreme importance as they tend to become widely involved in chronic urethritis, and the eradication of infection from their ducts and acini is the secret of the prevention of stricture. The dilatability of the urethra in all its parts must be tested and the presence of soft or hard induration or stricture excluded.

Females. The patient is placed on a cystoscopic couch and the vulva gently swabbed with warm disinfectant lotion. The affected parts are isolated with a sterile lithotomy towel and the surgeon seats himself between the patient's thighs. In the female, owing to the shortness of the urethra, both anterior and posterior parts of the canal are examined at the same sitting and with the same instrument. The urethroscope, with obturator in position, is passed into the bladder and any contained urine allowed to escape. Excess of moisture is removed with pledgets of cotton wool held in alligator forceps. The "head" of the urethroscope is attached to the tube, the light switched on, and the examination begun. All parts of the urethra are examined during withdrawal of the tube, but air distension is not employed, as for mechanical reasons dilatation of the female urethra is impossible. Special points to be observed are the presence of varying degrees of inflammation, urethral stricture (which is far commoner than is supposed), urethrocele, and carunculous degeneration of the urethra. A caruncle is usually recognizable without urethroscopy.

Urethroscopy. Posterior urethroscopy consists of the introduction of the urethroscope into the bladder and the examina-

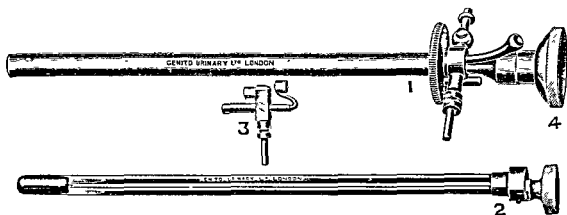


Fig. 1496.—GERINGER'S POSTERIOR URETHROSCOPE

1. Sheath.
2. Articulated obturator.
3. Proximal lighting attachment.
4. Telescope.

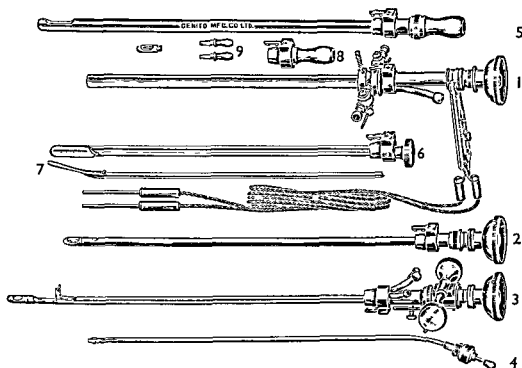


Fig. 1497.—CANNY RYALL'S CYSTO URETHROSCOPE.

1. Urethroscopic telescope assembled in sheath (direct vision).
2. Cystoscopic telescope (indirect vision).
3. Catheterizing and operating telescope.
4. Attachment with flexible end for use in conjunction with direct vision telescope (1). This controls the tip of the gum elastic catheter or bougie in the same way as the Albarran lever on (3).
5. Evacuator cannula.
6. Articulated obturator.
7. Double catheterizing attachment for operating telescope.
8. Faucet.
9. Tube mounts for lateral flushing cocks on sheath.

tion of that part of the urethra lying between the internal urinary meatus and the compressor urethrae muscle which is situated between the two layers of the triangular ligament. By this means alone can accurate information be obtained of the urethral aspect of the prostate, the condition of the prostatic ducts, the appearance of the verumontanum, and any deformity of the sinus pocularis, into the cavity of which the two ejaculatory ducts open.

In the female a posterior urethroscope is employed for the examination of the entire canal. Varying degrees of inflammation, the presence of hypertrophied tags of mucous membrane, or any deformity of the urethral aspect of the bladder neck can be readily diagnosed.

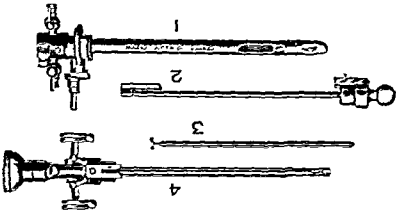


Fig. 1433.—McAllister's Cysto-Urethroscope.
 1. Sleeve.
 2. Obturator.
 3. Double catheterizing attachment.
 4. Operating telescope with Allmaras lever.

Posterior urethrosopy can be carried out alone or be combined with either direct or indirect cystoscopy.

Instruments, such as the Geringer, carry a direct vision telescope, and through this a limited view of the bladder can be obtained. In the Canny Ryall instrument, the direct vision telescope can be replaced by an indirect cystoscopic telescope, by means of which a complete cystoscopic examination may be carried out at the same sitting as posterior urethrosopy. An instrument, such as McCarthy's cysto-urethroscope, is fitted with a foroblique telescope which enables a modified view of both posterior urethra and bladder to be obtained. A double purpose instrument such as this, however, is not found to be wholly satisfactory. Of the three types of instrument described, the Canny Ryall cysto-urethroscope is of the greatest service (fig. 1497).

Technique. Males. The patient is directed to pass water and to lie on his back on a couch. The urethra is prepared and anæsthetised as for cystoscopy, after which he is placed on a cystoscopic couch. The following procedure applies equally to the Geringer or the Canny Ryall instrument.

The sheath, with obturator in position and cocked up to the necessary angle of 30° , is dried, well lubricated with lubafax and passed into the bladder in the same way as a cystoscope and firmly fixed in the jaws of a cystoscopic clamp (see fig. 1506). The beak of the obturator is returned to normal, the obturator withdrawn, any residual urine collected and its amount noted. The bladder is washed out two or three times by means of a stopcock connected by rubber tubing to an



Fig. 1493.—URETHROSCOPIC VIEW OF BLADDER NECK, SHOWING RELAXED INTERNAL SPHINCTER.

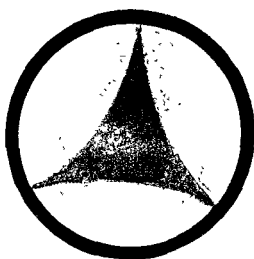


Fig. 1500.—URETHROSCOPIC VIEW OF BLADDER NECK, SHOWING INTRAVESICAL ENLARGEMENT OF ALL THREE PROSTATIC LOBES.

irrigator (see fig. 1507), filled with oxycyanide of mercury 1 in 8000, until the return flow is clear, and allowed to empty itself after the last wash. The bulb of the light stem is tested and this, together with the telescope, is inserted into the sheath. The surgeon seats himself on a stool between the patient's thighs, connects the inflow tap with the irrigator, switches on the light and begins the examination. The urethroscope is removed from the cystoscopic clamp and gently withdrawn into the posterior urethra. The inflow cock is opened, which will wash away any debris or other products of inflammation. The condition of the internal urinary meatus is first observed, and it will be found that only the floor and part of the sides of the opening are visible. In the normal subject extreme depression of the ocular end of the instrument is necessary before the roof of the meatus comes

into view. If this can be seen without depression it indicates a relaxed condition of the internal sphincter (fig. 1498), which may be due to a variety of conditions. Any abnormal bulging of either the lateral or median lobe of the prostate into the urethra should be noted (fig. 1500). By withdrawing the instrument, an excellent view is next obtained of the floor of the posterior urethra and the openings of the prostatic ducts. Special attention should be paid to the presence of inflammation, dilatation of their openings, or mucopus or other material

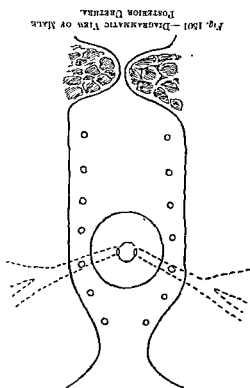


Fig. 1501—Diagrammatic View of Male Posterior Urethra.

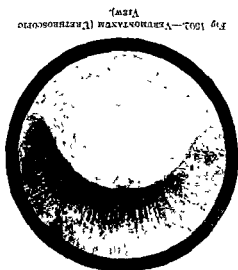


Fig. 1502.—Vermountaxum (Retrinoscopic View).

projecting thetrom. Occasionally a prostatic calculus can be seen in this situation. The prostatic ducts are some twelve to twenty in number on either side and open into two longitudinal grooves which are the prostatic sinuses, between which is situated the verumontanum—the next structure to come into view (figs. 1501 and 1502). This is a small elevation on the floor of the posterior urethra, composed of erectile tissue and a prolongation of muscular fibres from the trigone of the bladder, and is richly supplied with nerves. On its anterior aspect a slit-like orifice leads into a cul-de-sac in its substance—the utriculus masculinus or sinus pocularis. Situated in its cavity are the minute openings of the ejaculatory ducts which traverse the substance of the

prostate on their way from the epididymes. The projection of the verumontanum gives to this part of the canal a crescentic appearance, as seen through the urethroscope. It is important to note any enlargement, irregularity, papillomatous overgrowth (fig. 1503), or any degree of inflammation.

It is not always possible to see the openings of the ejaculatory ducts, but an attempt should be made by looking into the sinus pocularis. With the inflow cock open, the urethroscope is gently pushed back into the bladder and, if necessary, a direct vision inspection of this organ is carried out. If it is desired to perform a thorough cystoscopy, the urethroscopic telescope and light attachment are withdrawn from the

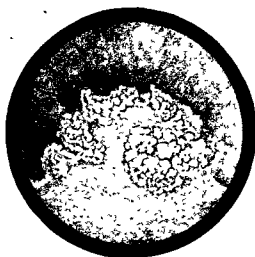


Fig. 1503.—PAPILLOMATOUS VERUMONTANUM
(URETHROSCOPIC VIEW).

sheath and replaced by the Canny Ryall indirect vision telescope. This examination differs in no way from that described under "Cystoscopy." With the Geringer instrument this procedure is not possible.

McCarthy's Cysto-urethroscope. This is passed in the same way as an ordinary cystoscope and fixed in the jaws of a cystoscopic clamp. The telescope is withdrawn, a faucet inserted and the bladder washed out and distended. The telescope is replaced, the inflow cock connected with the irrigating apparatus, and the examination of the bladder begun. As the line of vision is directed forwards at an angle of 30° with the shaft, the appearances will naturally vary, but with experience of this type of telescope a very satisfactory cystoscopy may be carried out. The bladder is emptied by opening the outflow cock, and the instrument is gently withdrawn into the posterior urethra, after closing the outflow and opening the inflow cock. Continual water distension is necessary to push the wall of the posterior urethra away from the

eye-piece, as this is in such close proximity; moreover, the individual parts will be greatly magnified for the same reason, and will vary in their relationship owing to the different angle of view. The urethroscope is again gently pushed forward into the bladder, the inflow cock closed, the telescope withdrawn, the faucet inserted, and the fluid evacuated. Withdrawal of the instrument completes the examination. All three types of instrument are fitted with a catheter channel, allowing different procedures to be carried out in the posterior urethra. The Canny Ryall sheath is made in various sizes, the largest permitting

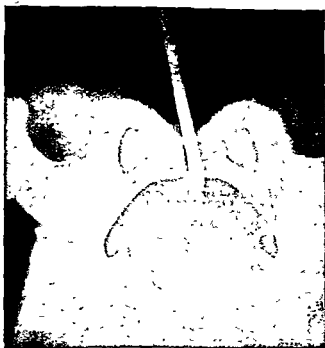


Fig. 1504.—VESICULOGRAM.

the passage of a No. 14 French electrode, which in the past was of great service in the coagulation of the median prostatic lobe. This, however, has now been replaced by the diathermy cutting current loop used with the McCarthy electrotome. Diathermic treatment can be applied to the verumontanum or to the prostatic ducts for liberating a calculus. The ejaculatory ducts can be catheterised for purposes of lavage of the seminal vesicles or the performance of an X-ray examination after their injection with sodium iodide (fig. 1504).

(d) *Cystoscopy.* Cystoscopic examination consists of the passage of a cystoscope into the male or female bladder and an inspection of

its entire interior. Other instruments such as single or double catheterising cystoscopes, urethrosopes, operating cystoscopes, lithotrites, etc., are all passed in the same way with the patient in the same position.

Cystoscopy is one of the most important urological procedures, as it gives accurate information concerning all affections of the bladder, and is of the greatest help in completing the diagnosis of diseases of the kidneys and ureters. If correctly carried out in the right position, through an adequately anæsthetised urethra, with aseptic precautions, and by a skilled instrumentalist, it should be both painless and free from risk, and can in the large majority of cases be performed as a routine in a properly equipped urological out-patient department or consulting room.

The equipment necessary consists of a cystoscopic couch, cystoscopic clamp, irrigating stand, cystoscopic stool, and cystoscopes.

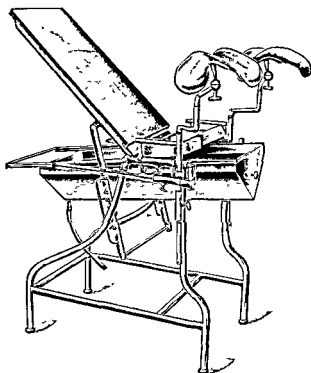


Fig. 1505.—ANDREWS' CYSTOSCOPIC COUCH.

Cystoscopic Couch. The object of this couch is to enable the patient to be placed in a position of maximum comfort and relaxation, and one which renders subsequent instrumentation and examination easy for the surgeon. The lithotomy position is the only one which fulfils these requirements, and is readily obtained on the couch shown in figure 1505.

It is built up on a seamless steel frame, and consists of adjustable back-rest, seat, leg-supports for lithotomy position, adjustable heel-supports, and detachable leaf. Its design differs in several respects from the conventional examination couch. The most important improvements are the seat and the freely adjustable leg-supports. The seat is fixed at a convenient angle to give the required forward tilt to the pelvis, and is of such a width that the patient automatically assumes the correct position for examination. The base, which has a deep perineal V-cut in front, is made of cast aluminium, and can be lifted off the frame for cleaning. The seat cushion consists of a rubber-sponge mattress one inch thick, held in position by a thick moulded rubber cover which overlaps the mattress and the metal base, far enough to prevent the accumulation of fluid between the seat and mattress. The moulded cover can be sterilised by boiling if necessary.

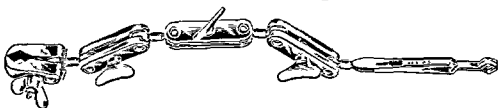


Fig. 1506.—CYSTOSCOPIC CLAMP.

The leg-supports for the lithotomy position are mounted on a ball-and-socket joint, which permits of free movement in every direction. The brackets for the leg-supports also carry extensible heel-supports (not shown in the drawing) which have a fitting midway to receive the leg-supports. The heel-supports are fixed on extensible steel bars, graduated in inches, to facilitate correct adjustment to the required length. When the patient has to remain for a prolonged period in the recumbent position with only the heels supported, the leg-rests under the knees are a great comfort. The back-rest and the detachable leaf are fitted with sponge-rubber mattresses. An anti-splash tray of ample length has been specially designed to catch any fluid which would otherwise soil the floor.

Cystoscopic Clamp (Fig. 1506). The object of this is to fix the cystoscope in any required position while the bladder is being washed out, or to permit the surgeon to change his position or demonstrate some particular view of interest to his assistant or others. Every unnecessary movement of the instrument causes additional discomfort to the patient and is to be strongly deprecated.

approximately the right position, the observation or other cystoscope removed from the disinfectant solution and its light tested by connecting it to the battery. Its sheath is wiped dry with a piece of sterile gauze and lubricated with lubafax, a small quantity of which has previously been squeezed on to another piece of gauze.



CYSTOSCOPIC TELESCOPE.



OBSERVATION SHEATH.



SINGLE CATHETERISING SHEATH.



DOUBLE CATHETERISING SHEATH AND FAUCET.

Fig. 1509.

The passage of a cystoscope in male cases can be conveniently described in three definite stages, although in practice there is no break in the continuity of the entire procedure. These stages are of much greater importance than in the female owing to the length and varying shapes of the urethra.

Male Cases. Stage 1. The surgeon stands between the patient's thighs, grasps the penis with retracted prepuce with the left hand, elevates it and inserts the instrument, which is held vertically with the right hand, gently into the urethra, letting it slide down by its own weight until it will go no further. At this point the beak, which is

directed during the whole procedure towards the patient, lies in the bulbous urethra just below the opening in the triangular ligament, where it joins the membranous portion (fig. 1510).

Stage 2. Tension is relaxed somewhat on the penis by the left hand, and the cystoscope is gently depressed to an angle of 30° with the horizontal, causing the beak to become level with the membranous urethra into which it will be felt to engage (fig. 1511).

Figure 1512 illustrates the result of depressing the cystoscope too far before the beak has entered the membranous urethra.

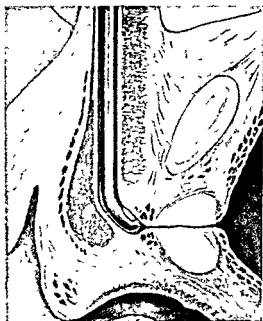


Fig. 1510.—Cystoscopy, Stage 1.

Stage 3. Tension is almost completely relaxed on the penis with the left hand, and the cystoscope is depressed to the horizontal. It is gently pushed in until its beak passes through the prostatic urethra into the bladder (fig. 1513). In cases of an enlarged median prostatic lobe the cystoscope may have to be depressed considerably below the horizontal before the beak can be made to ride over the obstruction on the floor of the prostatic urethra.

Obstruction may be encountered during Stage 1, before the beak has engaged in the membranous urethra, and this is invariably due to a stricture, in which case cystoscopy will have to be abandoned until the urethra has been dilated beyond 20° Charrière.

Obstruction during Stage 2 is usually due to spasm of the sphincter urethræ muscle; but this is rare when the urethra is efficiently anæsthetised with cocaine bicarbonate solution.

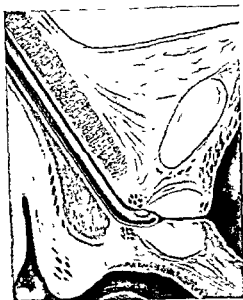


Fig. 1511.—Cystoscopy, Stage 2, THE RIGHT WAY.

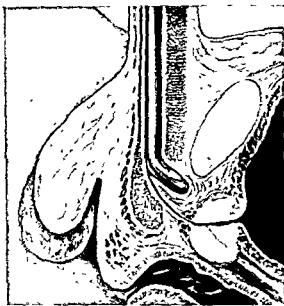


Fig. 1512.—Cystoscopy, Stage 2, THE WRONG WAY.

Obstruction during Stage 3 indicates the presence of fibrous or malignant disease of the prostate, or in rare cases an impacted stone. Glandular hypertrophy may sometimes give rise to difficulty from marked intravesical projection of the median lobe, which sometimes necessitates the use of an unusually long cystoscope, such as Swift Joly's, before the bladder can be reached.

The cystoscope is next fixed by means of the cystoscopic clamp, and the patient is warned to keep still as the instrument cannot move with him. The telescope is withdrawn, replaced in disinfectant solution, and the faucet inserted, any

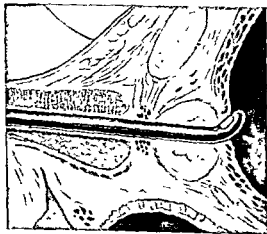


Fig. 1513.—Cystoscopy, Stage 3.

urine which escapes being collected and later measured and examined.

The bladder is washed out through the cystoscopic sheath with oxycyanide of mercury 1 in 8000 until the return flow, as seen through a glass held up to the light, is quite clear, after which the viscus is distended until the patient complains of a desire to pass water. The faucet is withdrawn and the telescope reinserted.

The surgeon sits on the stool, adjusted to the right height, and clips the flex on to the cystoscope. Having settled himself in a comfortable position, with his elbows resting on his knees or against some part of the table, the cystoscopic clamp is removed and the examination of the bladder is begun.

Female Cases. Stage 1. The surgeon seats himself between the patient's thighs and gently wipes the vulva with a swab wrung out in warm disinfectant lotion. The lips of the external urinary meatus are separated by the thumb and forefinger of the left hand, and the beak of the cystoscope is inserted into the urethra.

Stage 2. The cystoscope is depressed to the horizontal, and gently pushed into the bladder.

Obstruction may be encountered during Stage 1 from narrowing of the meatus, which may require dilatation with meatal dilators before the cystoscope can be passed.

During Stage 2 obstruction may also be met with, and is due to a stricture following long continued chronic urethritis. Dilatation with dilators is also necessary in this condition (fig. 1514).



Fig. 1511.—MEATAL DILATOR.

Theory of Cystoscopy.

By means of the modern self-rectifying cystoscope, objects in the bladder are seen in the same way as if the observer were actually standing on its floor with his body impaled by the beak of the instrument and always facing the direction in which it is pointing, that is to say, in the normal position of the cystoscope, towards the patient's head. Rotation of the cystoscope on its own axis corresponds to movements of the observer's head, his body being kept perfectly still. When the indicator is at 6 o'clock the observer's head is bent forward at a right angle

and he is looking at the floor of the bladder. At 9 o'clock his head is turned to the left at right angles to his body and he is viewing the right side of the patient's bladder. At 12 o'clock his head is bent backwards at a right angle and he is viewing the roof. At 3 o'clock his head is turned at a right angle to the right and he is viewing the left side of the patient's bladder. Movements of the cystoscope, other than rotatory, correspond to movements of the observer's body. Movements of insertion and withdrawal will cause the observer's body to take a few paces forwards and backwards respectively.

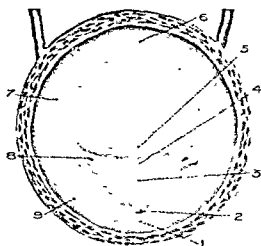


Fig 1515.—DIAGRAMMATIC VIEW OF OPEN BLADDER.
(After Macalister.)

- 1 Anterior wall.
- 2 Internal urinary meatus.
- 3 Trigone.
- 4 Inter-ureteric bar.
- 5 Retro-trigonal area or base fund.
- 6 Fundus.
- 7 Lateral wall.
- 8 Right ureteric orifice.
- 9 Lateral recess.

Lateral movements of the cystoscope will cause the observer's body to move laterally with the beak of the instrument over an arc, the centre of which is the membranous urethra—the fixed point of the cystoscope. Up-and-down movements cause elevation and lowering of the observer's body over a similar arc, but at right angles to the former one.

If the foregoing facts are firmly grasped, cystoscopy, with practice, should present little difficulty.

Examination of the Bladder (fig. 1515). This consists of a detailed inspection of the entire contents of the viscus.

To be complete, the examination must be carried out methodically and must follow a definite routine based on practical experience. For cystoscopic purposes the bladder can be divided by two antero-posterior planes into three zones—A, B, and C (fig. 1516), each of which can be covered by one revolution of the cystoscope. The middle zone B containing the air-bubble (fig. 1517), ureteric orifices (fig. 1518), inter-ureteric bar (fig. 1519) and part of the trigone, is usually the first to come into view and is therefore taken as the starting-point of the examination. By rotating the cystoscope in a clockwise direction with the fingers of the right hand, and steadying it by holding the light attachment

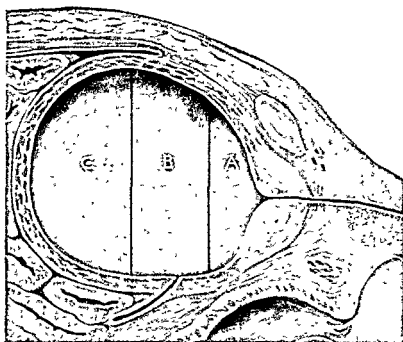


Fig. 1516.—BLADDER ZONES.

with the left, every portion of this zone is brought clearly into focus and its exact position defined and charted clock-face fashion by noting the position of the indicator situated on the optical end of the telescope. The first glimpse is of the roof at 12 o'clock where an air-bubble, which is invariably introduced during the washing-out of the bladder, is to be seen. Next the left wall is observed, until at 4 o'clock the left ureteric orifice comes into view. At 8 o'clock the right ureteric orifice is seen, this being connected to the left by the inter-ureteric bar. "South" of this (6 o'clock) lies the trigone which comprises

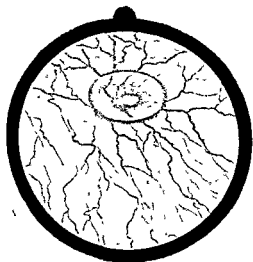


Fig. 1517.—AIR BUBBLE ON ROOF OF BLADDER.

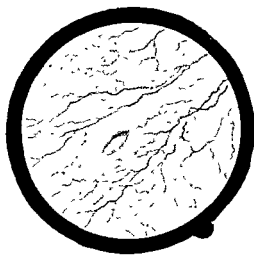


Fig. 1518.—NORMAL LEFT URETERIC ORIFICE.

the triangular strip of the bladder floor between the two orifices and the internal urinary meatus. Beyond 8 o'clock lies the right wall of the bladder, and further rotation brings the air-bubble again into view at 12 o'clock.

It is in this zone (B) that the majority of bladder growths and stones are observed, the favourite site for the former being above and to the outer side of one ureteric orifice, and for the latter in the trigone.

Evidence of tuberculous disease or other inflammation may be seen, and the condition of each ureteric orifice and the character of its efflux should be noted.



Fig. 1512.—INTER-URETERIC BAG.

The cystoscope is pushed further into the bladder until zone C is reached, and a complete revolution made which will cover the whole of the posterior part of the viscus. In this zone, apart from the characters of the mucous membrane and hypertrophy of its underlying muscular coats, as evidenced by trabeculation indicative of lower urinary tract obstruction, especial notice must be taken of any invagination of the bladder wall from pressure from without. This may be caused by a uterine fibroid, or by involvement of the bladder wall itself, as, for example, by a carcinoma of the cervix.

The cystoscope is finally pulled out until its beak comes to lie in zone A, which comprises the whole of the neck and a small part of the trigone on the floor of the bladder. This is dealt with last as it is the most sensitive part of the mucosa, and it is here that cystoscopic movements are most likely to cause discomfort.

In this zone, of greatest importance is the appearance of the prostate

in males, and the trigone in females, inflammation of the latter alone usually indicating an associated urethritis, and being very commonly secondary to a cervicitis or other source of chronic pelvic inflammation.

Cystoscopic inspection is now over, and the examination is completed by clamping the instrument in the 12 o'clock position, after pushing it a little further into the bladder so that the beak lies in zone B. The telescope is withdrawn, the lotion evacuated by inserting the faucet, the bladder again washed out until the return flow is clear, and the telescope replaced. The clamp is removed and the cystoscope withdrawn by an exact reversal of the procedure whereby it was inserted. Extreme gentleness is still indicated as many cystoscopies have been marred by careless withdrawal of the instrument, causing unnecessary pain and sometimes bleeding.

In male subjects the glans is gently wiped clean and the prepuce drawn forward over a piece of cotton wool, or the penis enclosed in a penile bag (fig. 1520), which prevents any staining of clothes by involuntary dribbling of urine, until the effects of the anæsthetic have worn off, or of blood in the event of congestion of the bladder neck.

Empirin compound 10 grs. and quinine hydrochloride 4 grs. are given as a routine, and washed down with a tablet of citralka (Parke, Davis & Co.) dissolved in a tumblerful of hot water; alkalis are prescribed three times a day until any discomfort on urination following instrumentation has passed off, when hexamine 10 grs. before and an acid mixture after meals are given for a week.



Fig. 1520.
PENILE BAG.

Chromo-cystoscopy. Although this is one of the renal function tests, it can be carried out at the same time as observation cystoscopy, and so will be described here.

Immediately before the cystoscope is passed, or in some cases during the examination, 5 cc. of a 0.4 per cent sterile solution of indigo-carmin are injected with aseptic precautions into the median basilic vein. As the dye is of an intense blue colour it is impossible to verify the position of the needle in the vein by withdrawing blood. If, however, a good tourniquet is applied and the vein rendered prominent by alternately clenching and unclenching the fist with the elbow straight and the syringe not quite filled, the entry of the needle

into the vein is heralded by complete absence of resistance of the piston on withdrawing it. The tourniquet is removed and the injection made, the small puncture being closed by pressure of a piece of lint or wool soaked in alcohol.

Indigo-carmin thus injected intravenously should be seen to emerge from each ureteric orifice in good concentration in from three to six minutes (fig. 1521).

Attention should also be given to the character of the efflux, a long-drawn-out gush with small force of projection often indicating



Fig 1521.—INDIGO-CARMIN EMERGING FROM
RIGHT URETERIC ORIFICE.

ureteric obstruction as by a pin-hole meatus, ureterocele, stricture, or impacted calculus.

Delay in appearance, in conjunction with feeble staining of the efflux, indicates damaged renal function, and its non-appearance a disorganised kidney, such as a hydro- or pyo-nephrosis or congenital absence of the kidney.

(e) *Ureteric Catheterisation.* Catheterisation of one or both ureters may be necessary for any of the following conditions: (1) to determine the patency of one or both ureters; (2) to collect a specimen from one or both kidneys for the performance of chemical or bacteriological examination or the estimation of the urea split function test; (3) for the performance of renal lavage; (4) for the carrying out of ascending or instrumental pyelography; (5) for the relief, in some cases, of renal colic due to a ureteric stone; (6) as an instrumental treatment for a stone impacted in the ureter; or (7) for the injection of drugs.

The patient is prepared and anaesthetised in the same way as for cystoscopy and placed on a cystoscopic couch.

Technique. A single or double catheterising sheath is selected, the light tested, lubricated with lubafax and passed into the bladder

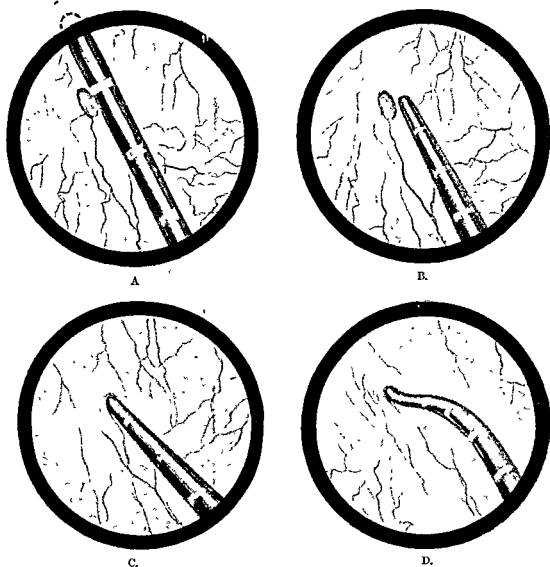


Fig. 1522.—URETERIC CATHETERISATION. A. URETERIC CATHETER PASSED ACROSS FIELD OF VISION. B. URETERIC CATHETER DEFLECTED INTO FIELD OF VISION. C. URETERIC CATHETER INSERTED INTO RIGHT URETERIC ORIFICE. D. KINKING OF CATHETER DUE TO URETERIC OBSTRUCTION.

in the same way as an observation cystoscope. It is unnecessary for the telescope to be inserted into the catheterising sheath as there is no danger of abrasion of the urethra, since the edges of the eye of the cystoscope are well rounded off. After clamping the sheath the faucet is inserted and, if necessary, a catheter specimen collected from the bladder. The viscus is washed out with oxycyanide of mercury 1 in

8000 until the return flow is clear, and distended with about 8 oz. of lotion. Over-distension, by flattening out the ureteric orifices, makes catheterisation difficult. After a general survey of the bladder, during which any abnormalities are noted, one or two sterile ureteric catheters, usually of No. 5 Charrière size, enclosed in sterile linen sheaths, are selected and the stilettes withdrawn. Should catheters be provided not fitted with stilettes, the patency of their lumen must first be tested with a syringe filled with distilled water as, if this is not done, it sometimes happens that blocking of the catheter is only discovered after it has been passed, when, of course, the whole procedure must be repeated to the patient's increased discomfort. The catheters are inserted into the catheter channels for a distance equal to the length of the instrument.

The surgeon seats himself on the stool, clips on the light flexes, switches on the light, removes the cystoscope from its clamp and rotates it through an angle of 180 degrees, when the trigone or inter-ureteric bar will come into the field of vision. The right ureteric catheter is pushed a little further on until its tip passes across the field of vision and disappears just beyond it (fig. 1522A). By turning the Albarran lever, the latter deflects the catheter away from the lens and again brings its tip into the field of vision (fig. 1522B). The cystoscope is rotated to 8 o'clock and the right ureteric orifice located. By a combined process of inserting the catheter a little further, turning the Albarran lever, and general movements of the cystoscope, the tip of the catheter is made to engage with the orifice (fig. 1522C) and the former gently pushed along the ureter until it reaches the pelvis. The Albarran lever is turned back to normal and the left ureteric catheter pushed across the field of view and deflected. The left ureteric orifice is located at 4 o'clock and the procedure repeated. Certain difficulties may be encountered, according to the state of affairs present: (1) Efficient cleansing of the bladder is essential in order to obtain a clear view, and this may require prolonged irrigation in the case of tuberculous cystitis, especially when secondary infection has occurred. (2) Marked intravesical projection of the prostate may obscure the ureteric orifices from view, but in this condition ureteric catheterisation is rarely indicated. (3) Gynaecological abnormalities of the uterus, by causing invagination or invasion of the bladder wall, may cause marked displacement of the orifice, which sometimes makes catheterisation impossible. (4) Location of the orifice. As a rule the ureteric orifices are readily located at 4 and 8 o'clock, but occasionally variations occur in their position which may cause difficulty to the inexperienced cystoscopist. The inter-ureteric

bar invariably leads to one or other orifice and this fact should be of assistance. The orifice may be markedly retracted, as in tuberculous ureteritis, or may be almost hidden in the swollen mucous membrane in cases of cystitis. (5) Abnormality of the orifice. The ureteric orifice may be pin-hole and fail to admit the tip of even the smallest catheter, or may end in a ureterocele and be equally impassable. (6) Over-distension, by flattening out the orifice and increasing its distance from the internal urinary meatus, may present difficulties which sometimes can only be overcome by running off some of the distending fluid. (7) Apparent obstruction is often encountered about an inch above the orifice and is usually due to a redundancy of the mucous membrane in this situation (fig. 1522D). The tip of the catheter engages with a fold of the lining membrane instead of passing up the lumen. Movements of insertion and withdrawal combined with rotation are, as a rule, sufficient to overcome this difficulty. (8) Obstruction may occur at higher levels and may be due to a variety of causes such as stricture, impacted stone, or inflammatory distortion of the canal. Patience, gentleness, or the use of a smaller sized catheter may be successful, but in some cases the passage of even the finest bougie is impossible. At times a fine bougie will succeed after a catheter has failed, and may dilate up the passage sufficiently for the latter to be successfully passed. (9) Obstruction of the pelvi-ureteric junction is most commonly due to a fixed kink produced by inflammatory adhesions between the pelvis and the ureter, or less commonly, to a stricture or the impaction of a stone. If ordinary manipulations fail, injection of sterile water through the catheter may sometimes be sufficient to dilate the affected part of the ureter and allow the passage of the catheter into the renal pelvis.

There are certain indications as to whether the catheter has reached the renal pelvis or is still in the upper ureter. On entering the pelvis, the educated touch will notice a sudden lack of resistance, comparable to that which occurs in the performance of lumbar puncture.

If the flow of urine from the catheter is observed, a regular drip will prove that the tip of the catheter is in the renal pelvis. A series of rapid drips followed by a distinct pause before a further series of drips occurs denotes that it is still lying in the ureter. The series of drips corresponds to a peristaltic wave of urine down the ureter, and the pause to the interval between two waves.

A further method of determining whether the tip of the catheter has reached the pelvis is to attach a syringe to the proximal end when withdrawal of the piston will remove a steady continuous quantity

of urine. If, however, the tip is still in the ureter, urine can only be removed by a series of interrupted jerks.

Ureteric catheters are made in sizes ranging from No. 4 to No. 16 degrees Charrière. Those of No. 7 size and upwards require an operating cystoscope for their passage. Two scales are commonly employed to denote their size: the Charrière which indicates their circumference in millimetres, and the Beniqué which is exactly double the Charrière scale, a No. 5 Charrière being thus equal to a No. 10 Beniqué.



Fig. 1523.—ORDINARY URETERIC CATHETER.

Catheters are made of cotton, linen, or silk thread into which a special form of shellac varnish is worked, known as "gum elastic." They are about 30 inches in length.

It is important to have a variety of different sizes of catheter at hand, not only because of congenital and pathological variations in the size of the ureter, but also because different purposes demand different sizes. The collection of renal specimens for the estimation of kidney function requires a large catheter to prevent leakage of urine down the ureter outside the catheter. For ascending pyelography, however, where over-distension of the kidney is to be avoided, a smaller catheter,



Fig. 1524.—WHISTLE TIP URETERIC CATHETER.

which will allow leakage around it is desirable. Two different types of catheter are commonly used. In the "olivary" type (fig. 1523) there is a solid rounded end with two or three lateral orifices situated at different levels on opposite sides proximal to it. The "whistle-tip" catheter (fig. 1524), on the other hand, has a terminal opening in addition to the lateral ones, and should be used as a routine, recourse being made to the former only in cases of difficulty. Ureteric catheters are marked by alternate dark and light areas of 1 centimetre interval, every 5 centimetres being shown by a number of rings which can be easily seen during cystoscopy. Thus at 15 mm. there are three rings. By this means, if the catheter is obstructed, the exact distance from the ureteric orifice can be ascertained. Ureteric catheters may be opaque or non-opaque. The former, as their name implies, will throw a shadow with X-rays, thus outlining the course of the ureter. Some

variation in opacity is observed on the X-ray plate corresponding to the light and dark segments.

A good quality catheter should be sufficiently supple to allow its passage through the cystoscope, past the Albarran lever, through the ureteric orifice and up the ureter into the kidney, yet stiff enough to prevent it coiling up in either the bladder or some dilated portion of the upper urinary tract. If too stiff, the point may be caught up in a fold of mucous membrane, rendering its passage a matter of great difficulty and often causing bleeding, pain, and injury to the ureter. On no account should a ureteric catheter be passed with its stylette *in situ*. The latter is only used to maintain a patent lumen while not in use, and to prevent kinking. Failure to observe this rule has in some cases resulted in perforation of the ureteric wall by the projection of the stylette through the terminal eye.

Ureteric catheterisation may be followed in certain cases by sepsis or hæmorrhage. Infection is rare if ordinary aseptic precautions are



Fig 1525.—URETERIC BOUGIE.

observed. Cystoscopes and ureteric catheters must be efficiently sterilised, and the latter only passed down the catheter channel after the bladder has been properly washed out. A few red cells are commonly found in the urine following catheterisation, but definite bleeding is usually due to lack of gentleness, the use of a rough, worn catheter, or its passage too far into the pelvis, with resultant bruising or laceration of a calyx or renal papilla.

(f) *Plain X-ray.* An ordinary X-ray photograph should be taken if a patient (i) complains of pain in one or other loin; (ii) has had an attack of renal colic, or (iii) has a swelling in the region of the kidney. Radiography for lower urinary tract symptoms is not of such great importance, except for the diagnosis of prostatic calculi, as the cystoscope and urethroscope give more accurate information. Although opinions regarding the preparation of the patient are divided, experience has shown that by far the best results are obtained where this is entirely omitted, though, if the patient has been confined to bed for a few days, an injection of 1 cc. of pituitrin is of value in stimulating peristalsis and ridding the bowel of excess of gas by the passage of flatus.

A first-class radiogram should fulfil the following conditions: (1) The

entire urinary tract should be shown on one film. (2) The outlines of both kidneys should be visible, together with the shadow of the psoas muscles. (3) Too soft a ray should not be used, otherwise a small opacity in the kidney will not be revealed.

Information is thus obtained regarding the size, shape and position of the kidneys, but this must be assessed in conjunction with the clinical aspects of the case, since slight alterations can occur without

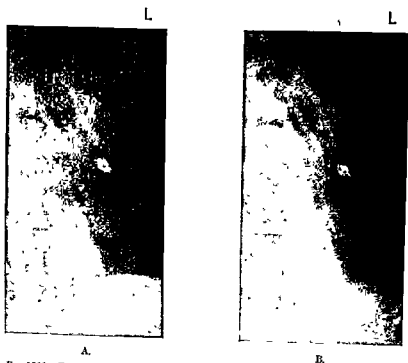


Fig 1526.—PLAIN X RAYS OF A RENAL CALCULUS. A FULL INSPIRATION. B. FULL EXPIRATION. BY COMPARING THE DOTTED LINES IN THE TWO PICTURES IT WILL BE SEEN THAT THE SHADOW OF THE STONE MAINTAINS A CONSTANT RELATION TO THE LOWER BORDER OF THE KIDNEY. AN ASCENDING PYELOGRAM OF THIS CASE IS SHOWN IN FIG. 1564.

being pathological, and conversely a kidney can develop a tumour of considerable size without appreciably deforming its outline as seen on an X-ray film.

Renal pelves and ureters cannot be seen without pyelography. If the bladder contains urine, its curved dome may throw a faint shadow just above the symphysis pubis which will vary with the degree of distension, but may be obscured by gas shadows in the rectum. Most renal and ureteric stones are radio-opaque, with the exception of uric acid calculi which throw no shadow. Cystine, oxalate, and phosphatic stones, in that order, all produce a shadow of good but varying density. It is often a matter of great difficulty to decide

R



Fig. 1527.—BRANCHED RENAL CALCULUS OF RIGHT KIDNEY. PLAIN X-RAY.

R



Fig. 1528.—RIGHT URETERIC CALCULUS AND TWO PHEBOLITHS. PLAIN X-RAY.

whether the shadow shown on an X-ray film is that of a stone in the kidney or in the ureter. A renal stone maintains a constant relation to the kidney on respiration (fig. 1526), and if large may assume the shape of a portion or the whole of the renal pelvis (fig. 1527). A ureteric stone is usually oval in shape with its long axis situated in the line of some part of the ureter (fig. 1528). Extra-urinary shadows, which may give rise to confusion, are due to: (1) calcified mesenteric and lumbar glands (see fig. 1535); (2) phleboliths in one or more of the pelvic veins (fig. 1528); (3) opaque intestinal contents; and (4) on the right side, gall-stones. The presence of a doubtful shadow of this nature is an indication for pyelography. Prostatic calculi usually throw a rather mottled shadow situated immediately behind or slightly above the symphysis pubis, and this, together with a consideration of other urological signs, is sufficient for diagnosis (fig. 1529). Radiology is of use as a preliminary measure to cystoscopy when vesical calculi (fig. 1529) are suspected, but it must be remembered that many bladder stones, though largely composed of oxalates or phosphates, may not throw a shadow unless a series of films of varying density and penetration of the ray is taken. On several occasions a positive cystoscopic finding has been followed by a negative radiological report, and in more than one instance has led to some discussion regarding the genuineness of the former.

Additional information as to the nature and position of an opaque shadow in the urinary tract can be obtained by taking stereoscopic X-rays. These, when viewed in a suitable screen, will enable the distance of the shadow from the anterior or posterior abdominal walls to be gauged.

(g) *The Opaque Ureteric Catheter.* An X-ray photograph, when taken after the passage of a ureteric catheter opaque to X-rays will, in most cases, be found to be of extreme value in determining whether a doubtful shadow is lying inside or outside the ureter (fig. 1530). The catheter accurately outlines the whole extent of the tube and its shadow will be in contact with that due to a ureteric calculus. By no means can these two shadows be divorced, though by taking plates from various angles the actual relationship of the stone shadow to the catheter shadow can be somewhat altered. An opaque catheter, when passed into the renal pelvis, will also aid in the diagnosis of a calculus situated in that cavity, though more exact information can be obtained by pyelography.

Pyelography. Pyelography consists of the radiographic demonstration of the renal pelvis, calyces, and ureter while filled with an opaque medium which can be introduced into the upper urinary tract in two ways. Intravenous pyelography consists of the injection of a pyridine derivative with a high percentage of iodine in close combination—such as uroselectan B—into a vein of the arm whence it is carried by the blood stream to the kidneys which excrete it into the renal pelvis



Fig. 1529.—VESICAL CALCULI (UPPER GROUP OF SHADOWS) AND PROSTATIC CALCULI (LOWER GROUP OF SHADOWS) PLAIN X-RAY.



Fig. 1530.—OPAQUE URETERIC CATHETER AND STONE IN LOWER PART OF RIGHT URETER.

and ureters. The shadow obtained by subsequent radiography will give a true representation of the physiological activity of the kidney and the state of affairs which normally occurs during excretion.

Instrumental or ascending pyelography consists of the injection of sodium iodide through a ureteric catheter into the renal pelvis, its distension to a degree which must be limited by discomfort in the loin, and the subsequent taking of a radiogram. The shadow thus obtained is an anatomical aspect of the upper urinary tract at full distension, and

differs materially from that obtained by the intravenous or physiological method. Much skill and experience are necessary for the correct interpretation of the shadows obtained by both these methods, and close co-operation between radiologist and urologist is essential.

Pyelography is indicated in the following conditions: (1) When the plain X-ray is inconclusive. (2) In all cases of hæmaturia, shown by cystoscopy to be unilateral and not due to acute pyelonephritis. (3) In all cases of renal or ureteric pain, either as an adjunct to other methods of investigation or as a means of determining the cause. (4) In most chronic renal infections. (5) To establish the relationship of the urinary tract to neighbouring palpable swellings of doubtful origin. (5) To establish the intra- or extra-urinary position of shadows shown by a plain X-ray. (6) As a preliminary to most operations on one kidney. (7) To establish the presence and the functional capacity of the other kidney.

Information supplied by Pyelography. Pyelography will demonstrate the size, shape and position of the renal pelvis, calyces, and ureter and their relationship to shadows seen on a previous plain X-ray. It will reveal the presence of congenital abnormalities in the upper urinary tract, and will help to differentiate between renal swellings and neighbouring tumours of a doubtful nature.

(h) *Intravenous Pyelography.* Pyelography by the intravenous route enables a physiological outline to be obtained of the renal pelves, ureters and bladder. The shape of the pelvic shadow represents an actual picture of the cavity of the kidney while engaged in its excretory function, and will depend on the condition of the kidney at the time of the photograph. The depth of concentration of the dye and its time of appearance are valuable indications of the renal function and will be discussed under "Renal Function Tests," to which it forms a most important addition.

Preliminary preparation of the patient is neither necessary nor advisable, and a plain X-ray should invariably be taken before this method of pyelography is carried out. 20 cc. of a warm sterile solution of uroselectan B are injected with a syringe and needle into the median basilic vein, after rendering it prominent by the application of a tourniquet. Certain points connected with the injection should be strictly observed: (1) *Leakage.* Great care should be taken to ensure that the needle is in the vein and that it remains there throughout the period of injection. If leakage occurs into the subcutaneous tissues

the medium in some cases will produce a reaction as shown by swelling, pain, and redness of the affected area, which may take some days to pass off. At the least appearance of a bulge under the skin the procedure must be discontinued, and it is wise in such cases to reinsert the needle into another vein for the remainder of the injection. (2) *Injection time*. The solution should be injected slowly at a rate not exceeding 10 cc. a minute. Failure to observe this may lead to severe cramp-like spasms along the line of the vein and, in some cases, to a feeling of giddiness and faintness. (3) *Size of needle*. Uroselectan B is rather an oily solution and requires a slightly larger needle than that which is used for an ordinary intravenous injection. (4) *Thrombosis*. An occasional complication is thrombosis of the vein, and this should be anticipated by injecting a few cc. of saline after the injection and massaging the arm from elbow to shoulder while held vertically. The small puncture produced should be sealed with a piece of strapping.

X-ray photographs are usually taken at 5, 15, 30 and 45 minutes after the injection. The plates are developed immediately and the shadow of the medium observed. If the latter is of poor concentration and the pelvis only imperfectly filled, further pictures must be taken until a diagnostic radiogram is secured which, in some cases of hydro-nephrosis, may require an interval of $1\frac{1}{2}$ hours or even longer, or may not be obtained at all. In most cases the patient lies flat on his back throughout the whole procedure, but it is sometimes of advantage to tilt the table until the head is some three feet below the level of the feet. This, to some extent, delays the rate of emptying of the pelvis and results in an improved pyelogram. Abdominal compression similarly improves the filling and definition of the pelves and calyces, at the expense, however, of obtaining a true physiological representation of the renal function. If the case is one of a movable kidney, a second plate should be taken with the patient standing, whereby an estimate of the range of mobility of the organ can be obtained by a comparison of the two plates. Beyond ensuring an adequate pyelogram free from movement, the X-rays are not examined until completely dry, and are then viewed in a screen, preferably by both radiologist and urologist at the same time.

Normal and abnormal pyelograms and ureterograms are discussed on pages 2742 and 2744.

(i) *Ascending or Instrumental Pyelography*. Instrumental pyelography is carried out by the injection through an opaque ureteric

catheter of sodium iodide solution, followed by the taking of an X-ray plate which thus represents an anatomical outline of the renal pelvis and calyces when fully distended with opaque fluid. It is advisable to add some colouring material such as coupler blue to the sodium iodide, as cases have occurred in which surgical spirit has been injected by mistake. A 12 per cent solution is employed as this is isotonic.

General anæsthesia is contra-indicated because of the risk of over-distension of the pelvis (fig. 1531) and of the impossibility of securing an absence of movement during the necessary time of exposure.

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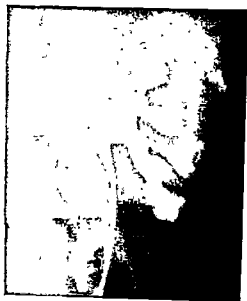


Fig. 1531.—ASCENDING PYELOGRAM SHOWING PENETRATION OF SODIUM IODIDE INTO THE RENAL TUBULES FROM OVER-DISTENSION.

In the male, the urethra is anæsthetised with cocaine bicarbonate solution and the patient placed in the lithotomy position on an X-ray table. In the female no previous anæsthetic is necessary.

A single or double catheterising cystoscope is selected and passed in the usual manner. The bladder is washed out and distended with boracic lotion, 1 oz. to the pint. On no account should oxycyanide of mercury be employed as, when in contact with sodium iodide, mercuric iodide is formed which is extremely irritating to the bladder and may produce sloughing of its wall. A No. 5 Charrière opaque ureteric catheter, already sterilised in its sheath, is selected, pushed into the catheter channel and passed up to the kidney, as described under "Ureteric Catheterisation."

If a double pyelogram is to be performed, a second catheter is passed through the other channel to the opposite kidney in a similar manner.

By using a No. 5 Charrière, space is left between it and the ureteric wall for the return flow of the opaque fluid, which acts as a safety valve and prevents over-distension of the renal pelvis. The catheters are pushed into the catheter channels as far as they will go and the cystoscope removed after emptying the bladder, the catheters being left in position. This greatly increases the comfort of the patient during subsequent procedures. A plain X-ray, with the catheters *in situ*, is taken and immediately developed in order to confirm their position, and is useful for checking the correct time of exposure of the plate. An Andrews' pyelogram nozzle fixed to a Record syringe (fig. 1532) is inserted into the ureteric catheter and the contents of the renal pelvis removed by aspiration to prevent dilution of the opaque



Fig. 1532.—ANDREWS'
PYELOGRAM NOZZLE.

medium. Another syringe charged with a warm sterile solution of 12 per cent sodium iodide is attached to the nozzle and its contents are slowly injected into the renal pelvis. The patient is asked to announce the first feeling of discomfort in the loin, which indicates that the pelvis is full.

If a double pyelogram is to be carried out, the same procedure is repeated on the opposite side.

A radiogram is taken immediately and is followed by the removal of the sodium iodide from each renal pelvis. If this is not done there may be considerable after-pain in the loin. A record is kept of the amount of iodide injected and withdrawn, which in the normal condition should not exceed 7 cc. In some cases a third radiogram is taken after emptying the renal pelvis. By this means it is sometimes possible to demonstrate the presence of a uric acid calculus (which otherwise would throw no shadow) by adhesion of the iodide to its surface.

Obstruction to the catheter in some part of the ureter, even though a smaller size is tried, will still enable an ascending pyelogram to be carried out, although a larger quantity of sodium iodide is necessary. The solution first enters the ureter and though some regurgitation takes place a sufficient amount will reach the pelvis to bring about

complete filling, as indicated by the characteristic discomfort in the loin.

An alternative method of inserting the opaque solution into the renal pelvis is by means of gravity, and this is a much safer procedure when the surgeon has no great experience of pyelography. A fine rubber tube is connected to the catheter and to a Record syringe, from which the piston has been removed. By filling the syringe and raising it some two feet above the level of the patient, the iodide will flow in by gravity. In the hands of an expert, however, the injection method is devoid of risk.

Instrumental Ureterogram. An anatomical outline of the ureter when distended with opaque fluid is obtained by the passage of a larger catheter for a distance of about two inches up the ureter. An injection of sodium iodide 12 per cent is made with a Record syringe and an Andrews needle in the same way as for pyelography, and stopped immediately discomfort is experienced in the loin. In this way a uretero-pyelogram is obtained.

Instrumental Cystogram. A radiological outline of the bladder can be obtained by passing a catheter, emptying the viscus of any contained urine and filling it with a solution of 12 per cent sodium iodide until the patient expresses a desire to micturate. In this way definite information can be obtained of the size, shape and position of a vesical diverticulum (fig. 1533), and in some cases the method will indicate a vesical growth or intravesical enlargement of the prostate by the presence of a filling defect. Trabeculation and false diverticula resulting from bladder-neck obstruction may occasionally be shown (fig. 1534).

Comparison of Intravenous and Instrumental Pyelography. Intravenous pyelography should be used as a routine, and in the majority of cases will furnish the observer with all the information he requires. Its advantages are that bilateral pyelography, ureterography and cystography are performed at one sitting, and at the same time an estimate is obtained of the renal function by gauging the depth of the shadow and the time of its appearance. In many cases it can be carried out when instrumental pyelography is impossible. Intravenous pyelography, though providing a most important additional aid to diagnosis, in no way replaces cystoscopy and ureteric catheterisation, and its results must be assessed in conjunction with these other methods of investigation.



Fig. 1533.—CYSTOGRAM SHOWING A VESICAL DIVERTICULUM ON THE RIGHT SIDE.

Instrumental pyelography is indicated when the results of the intravenous method are inconclusive, and should always be performed in cases of suspected renal growth. By this means minor degrees of filling defect are revealed which may escape detection by the intravenous method. It is contra-indicated in acute inflammation of the urinary tract, in severe chronic inflammation, and when instrumentation is followed by urinary fever. It is best avoided in tuberculosis,



Fig. 1534.—CYSTOGRAM SHOWING TRABECULATION OF THE BLADDER AND THE PRESENCE OF A FALSE DIVERTICULUM ON THE RIGHT SIDE.

but the importance of early and accurate diagnosis of this disease is such that an ascending pyelogram should be performed if confirmation is still required after cystoscopy, urine analysis and intravenous pyelography have been carried out.

Normal Pyelogram. Wide variations in the shadow outlining the renal pelvis and calyces can occur but yet be within the limits

R



Fig. 1535.—Normal Intravenous Pyelogram. A Calcified Gland is seen at the Level of the 5th Lumbar Vertebra on the Right Side.

of normal. Braasch has divided the normal pyelogram into a series of types, but it will be sufficient here to describe the commonest of these.

The renal pelvis is trumpet-shaped and continuous at its outer margin with the renal calyces and at its inner and lower angle with the ureter (figs. 1535 and 1536). The inner border of the pelvis usually curves outwards and then upwards into the upper calyx. The lower border of the pelvis sweeps outwards and downwards in a uniform curve into the lowest calyx. The middle calyx opens into the outer margin of the pelvis. The calyces are divided into major or primary, and minor or secondary. The major calyces are usually three in number, communicate with the renal pelvis as has been described, and are, as a rule, slightly constricted in their centre. Each primary calyx ends in two or three

minor ones which in a pyelogram are seen as cup-shaped shadows. This cupping is due to the projection of the apex of a papilla into the calyx. The shape of the minor calyx depends on the angle from which the X-ray is taken, and is one of the first structures to undergo a change as a result of back pressure and



Fig. 1536.—NORMAL ASCENDING PYELOGRAM.

infection. As a rule there is nothing to indicate the pelvi-ureteral junction, there being a gradual transition from pelvis to upper ureter.

With the patient lying supine the pelvi-ureteral junction, as shown in the pyelogram, is situated opposite the transverse process of the second lumbar vertebra, but is slightly higher on the left than on the right side. The calyces themselves may reach as high as the eleventh rib and as low as the transverse process of the third lumbar vertebra, or even lower in cases of visceroptosis.

The Abnormal Pyelogram. Owing to the wide variations of the normal pyelogram, extensive experience is necessary on the part of both radiologist and urologist before the findings can be interpreted as abnormal. Special emphasis must be laid on the following points :

Shadow of the Pelvis. (1) Alterations in size of pelvis : an increase is due to hydronephrosis or pyonephrosis (fig. 1537). (2) Alterations in



Fig. 1537.—RIGHT ASCENDING PYELOGRAM SHOWING DILATATION OF THE PELVIS AND CALYCES. THE PELVI-URETERAL JUNCTION IS RAISED, KINKED AND CONTRACTED.

shape of pelvis : the outline of the pelvis may be encroached upon by the invagination or the intra-pelvic projection of a renal growth (see fig. 1571), or by the presence of a stone (see fig. 1564), blood clot or pus

in its cavity. In some cases an area of diminished density is observed in the shadow, due to the presence of a stone which displaces the opaque medium, or by a mottled shadow, due to its permeation amongst the villi of an intra-pelvic papillary carcinoma. (3) Alterations in position of pelvis: the relation of the pelvic shadow to neighbouring structures is altered if undue mobility or fixed displacement of the kidney is present. (4) Alterations of pelvi-ureteral junction: the junction of the pelvis and ureter, instead of being gradual, may be contracted, kinked, or displaced to a point above and behind the lower level of the pelvic shadow (fig. 1537). These distortions indicate various types of inflammatory processes. (5) Duplication: this occurs when a double pelvis is present (see fig. 1543).

Shadow of Calyces. (1) The normal cup or chalice-shape of some or all of the minor calyces (fig. 1538a) may be replaced by some degree of flattening (fig. 1538b and c) which may proceed to actual clubbing



Fig. 1533.

(fig. 1538d). These appearances are due to absorption of the papillae which project into the calyces, as a result of back pressure, infection, or a combination of the two, and indicate varying degrees of pyelonephritis. (2) Dilatation of the calyces is due to a varying degree of hydro- or pyo-nephrosis, and is usually accompanied by distension of the pelvic shadow (fig. 1537). (3) A group of minor calyces may be replaced by an irregular mottled shadow indicating excavation of the renal parenchyma, such as may occur in tuberculous disease (fig. 1539), or be due to the necrosis of a neoplasm. (4) Elongation of the major calyces may be due to any condition causing enlargement of the kidney, such as hypertrophy, new growth, or polycystic disease (see fig. 1567). (5) A shadow which is present on plain X-ray may become partially or completely obliterated by the shadow of the opaque medium in a major calyx, thus proving the presence of a calculus and stressing the importance of a preliminary film before pyelography is carried out (see figs. 1526 and 1564). (6) Alteration in position of the calyces: The shadow of calyces on the inner side of the ureter indicates rotation of the kidney which is invariably due to congenital abnormality,

i.e. some variety of united or horseshoe kidney (see fig. 1542). The two pelvic shadows may appear nearer the mid-line than normal, or one pelvis may be considerably lower than the other, or both pelves may be on the same side, one above the other. Owing to the fact that the kidneys are rotated and are being viewed from an unusual angle, the pelvic outlines appear different from those of normal kidneys, and



Fig. 1539.—TUBERCULOUS EXCAVATION OF UPPER GROUP OF CALYCES AND PELVIC HYDRONEPHROSIS.



Fig. 1540.—HYDRO-URETER AND HYDRONEPHROSIS DUE TO A PIN-HOLE URETERIC ORIFICE. ASCENDING PYELOGRAM AFTER URETERIC MEATOMY.

the shadows of some of the calyces are superimposed on the pelves. The two ureters pass in front of the connecting band of tissue and may overlap the lower calyces.

Shadow of Ureter. The radiological outline of the ureter may be altered by the presence of a stricture, calculus, or tuberculous disease. Some distension of the tube is usual above the seat of obstruction (fig. 1540). It must be remembered that some degree of narrowing of the

normal ureter occurs below the pelvi-ureteral junction, at the brim of the bony pelvis and at the junction of the ureter with the bladder. Stenosis of the ureteric orifice may lead to dilatation of the whole tube, which may end below in the form of a rounded swelling if a ureterocele is present. Duplication of the ureteric shadow indicates a double ureter (see fig. 1543), and it will usually be noticed that the shadow communicating with the upper renal pelvis crosses the shadow of the other ureter and enters the bladder at a lower level on the trigone.

Individual variations of the urogram will be described under the various diseases by which they have been caused.

(j) *Renal Function Tests.* Before any operation on the urinary tract is undertaken, it is essential, except in cases of emergency, to estimate as accurately as possible the functional capacity of one or both kidneys. Failure to do so will invariably result in disaster sooner or later. The renal function can be estimated in three ways: (1) By the recognition of the symptoms and signs of renal failure (see page 2670). (2) By the examination of the urine, and (3) by the performance of certain renal function tests.

Examination of the urine. This has already been described at length on page 2701. A persistent low specific gravity and a constant diminution in the percentage of urea indicate a seriously impaired renal function. Both polyuria and oliguria may also be evidences of renal insufficiency.

Renal function tests. Substances used for excretion tests are dealt with by the kidney in the same way as the poisonous waste products of the body, and an accurate estimation of their elimination or their retention in the blood will thus provide a true indication of the renal function. Two types of tests are commonly used: (i) the dye tests, of which the most popular substances used are indigo-carmin and uroselectan B; and (ii) the tests of elimination or retention in the blood of substances which are normally formed during metabolism, such as urea. Many other tests have been performed for the estimation of renal function, but will not be described here.

(i) *Indigo-carmin* (see also Chromo-cystoscopy). 5 cc. of 0.4 per cent solution of indigo-carmin are injected intravenously and the time of appearance of the dye and depth of coloration of the efflux are observed from each ureteric orifice by an observation

cystoscope (see fig. 1521). In the normal kidney the dye should appear in from three to six minutes, the second and succeeding effluxes being more deeply stained than the first. Delay in appearance of the dye indicates damaged renal function, and its non-appearance a disorganised kidney, such as hydro- or pyo-nephrosis or congenital absence of the organ. The depth of coloration of the efflux must be considered in conjunction with the excretion time; thus, if an interval of seven minutes elapses before elimination of the dye, and in addition poor staining is noted, the kidney should be regarded with suspicion. Harris and Macalpine view the elimination of indigo-carmin as a most delicate test, it having been found by them to indicate very faithfully minor disturbances of renal function.

Uroselectan B (see also Intravenous Pyelography). After a preliminary film, 20 cc. of uroselectan B are injected intravenously and X-rays taken 5, 15, 30 and 45 minutes after injection. The time of appearance of the pyelographic shadow, together with its depth of concentration, furnishes a valuable estimation of the functional capacity of both kidneys, as well as giving evidence of any abnormality present. A normal kidney should throw a good shadow within five minutes of injection. The test resembles that of indigo-carmin, except that radiography instead of cystoscopy is used for observing the excretion time.

(ii) *Urea concentration test.* By the administration of a large quantity of urea by mouth, the amount of this substance in the blood rises and is eliminated in the urine by the kidneys. By estimating the percentage of urea during the second and third hours after ingestion, the total renal function can be gauged. 15 grammes of urea dissolved in 100 cc. of water are given by mouth, no fluids having been allowed during the previous twelve hours. Urine is passed or collected through a catheter or suprapubic tube at the end of the first, second, and third hours. The first specimen is discarded, owing to some degree of diuresis which the urea produces. The percentage of urea in the second and third should be over 2 per cent. Normally about 120 cc. of urine are passed during each hour, and an increase or decrease of this amount must be allowed for. Thus if 160 oz. are passed containing 2 per cent urea the latter must be multiplied by 160 and divided by 120 to obtain a true estimate of the renal function. The estimate of the renal function obtained by this method applies to the functional capacity of both kidneys as a whole, and gives no indication of the contribution made to it by each kidney.

Urea split function test. The capacity to concentrate urea by each kidney is determined. As in the urea concentration test, 15 grammes of urea in 100 cc. of water are given by mouth. A double catheterising cystoscope is passed $1\frac{1}{2}$ hours later and the ureters catheterised. A few cc. of urine are collected from each kidney and the percentage of urea estimated in each. The amount in a healthy kidney should exceed 2 per cent.

Blood urea test. This constitutes a most important test of total renal function. 5 cc. of blood are withdrawn from the median basilic vein and immediately injected into a test-tube containing calcium oxalate. The blood is vigorously shaken to prevent clotting. The amount of urea is estimated in terms of milligrammes per cent, and in the presence of a normal total renal function should not exceed 50. Estimation of the total functional capacity of the kidneys is essential in such operations as prostatectomy. The urea concentration and blood urea tests should both be performed and their results assessed in conjunction as, in my opinion, it is unwise to place too much reliance on one test alone. Thus a patient with a blood urea of 70 mgms. per cent may have a normal urea concentration test of over 2 per cent in the second and third hours. Again, a poor concentration test of 1.5 to 1.7 has been observed when the blood urea was only 45. The following combination should be regarded as evidence of good renal function: Blood urea 45 mgms. per cent, urea concentration 2.2 per cent in second hour, and 2.6 per cent in third hour.

CHAPTER II

DISEASES OF THE KIDNEY

CONGENITAL ABNORMALITIES

(1) *Solitary Kidney* and *Atrophic Kidney*. In solitary kidney the opposite kidney is completely absent, and cystoscopic examination shows only one ureteric orifice, which may be in its normal position or displaced towards the mid-line. In atrophic kidney the organ is functionless, but a ureteric orifice is present in its normal position. In both cases the functioning kidney is larger than normal and may be lobulated or irregular in shape. The opposite half of the trigone is atrophied.

The possibility of such conditions serves to emphasise the importance of complete urological investigation, especially with reference to the function of the opposite kidney before any operative procedure on a diseased kidney is undertaken (fig. 1541).

(2) *Fused Kidneys*. The commonest variety is the horse-shoe kidney in which, as a rule, the lower poles are united by a bridge of renal substance or fibrous tissue, or a mixture of the two, which passes across the mid-line in front of the aorta and inferior vena cava.

The kidneys are at a lower level and lie closer to the mid-line than normal, and the two ureters pass down in front of the uniting band.

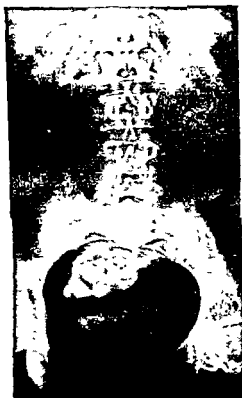


Fig. 1541.—INTRAVENOUS PYELOGRAM SHOWING A SOLITARY ECTOPIC KIDNEY CONTAINING STONES. NOTE THE ABSENCE OF THE PYELOGRAPHIC SHADOW ON THE OPPOSITE SIDE.

Abnormality of number and position of the renal vessels frequently co-exists.

The condition may give rise to no symptoms, or be mistaken for a pelvic tumour if low lying.

Diagnosis. This is usually impossible without pyelography, and even then may be difficult (fig. 1542).



Fig. 1542.—HORSESHOE KIDNEY: DOUBLE ASCENDING
PYELOGRAM.

Treatment. This is only required if one half of the horseshoe kidney is attacked by disease. Precise diagnosis is essential, and may indicate removal of stones or nephrectomy after ligation and division of the connecting bridge of tissue.

(3) *Fixed Misplacement or Ectopic Kidney.* By fixed misplacement is meant the congenital absence of the kidney from its usual position in the loin and its presence in an abnormal position from which it cannot be moved, the condition thus differing from a movable kidney.

In such cases the renal artery usually arises low down from the aorta or from the iliac artery. The kidney may be found at the bifurcation of the aorta, at the promontory or in the hollow of the sacrum, or in the iliac fossa.

Symptoms and Signs. There may be none, but if the kidney is diseased there will be pain which is referred to the corresponding loin, and other symptoms resembling the same disease in a normally placed organ. In women there may be some interference with menstruation, pregnancy and parturition.

Diagnosis. This is made by finding the kidney fixed in an abnormal position, by pyelography, and by the symptoms due to the particular disease affecting the misplaced kidney.

Treatment. If the kidney is diseased or giving rise to marked symptoms, nephrectomy is indicated, provided that the opposite kidney has been shown to be efficient.

(4) *Bifid Pelvis and Double Ureters.* A kidney may have two complete pelves, each with its own ureter which may enter the bladder through a separate ureteric orifice. The condition very rarely occurs on both sides. The ureter draining the upper pelvis usually crosses the other and opens on the trigone at a lower level.

In many cases the duplication is not complete, the ureters uniting and entering the bladder as one single tube. Other variations may occur, such as one ureter opening in an abnormal situation, for example, into the male seminal vesicle or prostatic urethra or into the female urethra or vagina, giving rise to incontinence of urine. One ureter may end blindly in some part of the bladder wall in the form of a cyst, or its opening may be contracted with resulting atrophy or hydronephrosis of the corresponding part of the kidney.

Symptoms and Signs. These depend entirely on the type of abnormality present. Even when the condition is bilateral there may be no signs or symptoms. The most common are due to hydro-ureter and hydronephrosis of the corresponding part of the kidney, but any disease which can attack a normal organ may occur.

Diagnosis. This is made by cystoscopy and pyelography, both intravenous and instrumental (fig. 1543).

Treatment. In some cases the hydronephrotic part of the kidney can be removed with its pelvis, without interfering with the blood supply and function of the remaining portion, but the operative procedure will depend entirely on the condition found.

If a ureter opens in an abnormal situation an attempt may be made to dissect it free and implant it into the bladder, or it may be tied with resulting atrophy of the corresponding part of the kidney, provided the ureteric specimen is sterile.

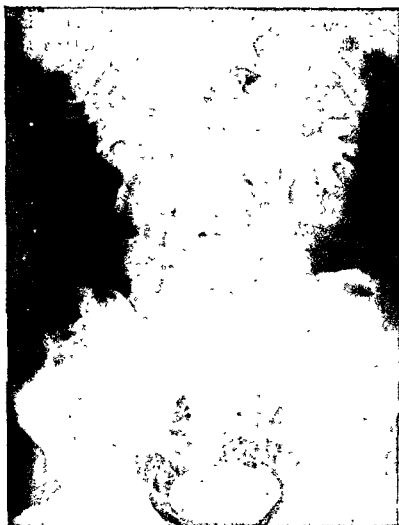


Fig. 1543.—INTRAVENOUS PYELOGRAM SHOWING A BIFID PELVIS AND TWO URETERS ON THE LEFT SIDE.

(5) *Congenital Cystic Disease.* This will be described under "Cysts of the Kidney" (see page 2809).

(6) *Movable and Floating Kidney.* In the normal individual the range of movement of the kidney within the peri-renal fascia behind

the peritoneum due to respiration is limited to $1\frac{1}{2}$ inches. If the mobility is only slightly increased, so that the lower half can be felt on deep inspiration, it is described as a *palpable kidney*. If, however, the examining hand can define the upper border of the organ and can prevent it from returning into the loin during expiration, the term *movable kidney* is applied to it. Some movable kidneys can be pushed freely about the abdomen in all directions, and occasionally be made to cross the mid-line. The suprarenal capsule does not move with the kidney.

A *floating kidney* is a very rare congenital condition in which the organ is completely surrounded by peritoneum and has its own mesentery containing the constituents of the renal pedicle. It is thus an intra-peritoneal organ but cannot be distinguished from a movable kidney without operation.

In ordinary circumstances a kidney, surrounded by its true capsule, lies within a fixed sheath or peri-renal fascia, and the normal respiratory movements take place inside it. Connecting the renal capsule and peri-renal fascia are a number of delicate fibrous septa which run between a mass of peri-renal fat, on which the lower pole of the kidney rests.

One thickened bundle of fibres, the suspensory ligament of the kidney, runs from the upper and inner aspect of the renal capsule, through the upper part of the peri-nephric fascia, and is attached to the spine in the region of the crus of the diaphragm. It is the only bundle which can in any way claim to support the kidney. The main factor which keeps the organ in its normal position is adequate intra-abdominal pressure maintained by the tonic contraction of the abdominal muscles.

Movable kidney occurs commonly between the ages of 25 and 30 years, and is ten times more common in women than men, and on the right side than the left.

It may exist alone or form part of a generalised visceroptosis.

In many cases no cause whatever can be discovered for the condition, but, as a rule, there is some factor present which lowers the intra-abdominal pressure, such as loss of tone of the abdominal muscles after parturition, certain illnesses which cause a rapid loss of intra-abdominal, and especially of the perinephric fat, and the removal of abdominal tumours. Also individuals with long narrow chests, very sloping lower ribs and shallow loins have a natural tendency to a lack of muscular tone. With loss of support to the kidney from this diminished tension, all the fascial connections become stretched and the peri-renal fat absorbed, allowing of greatly increased mobility of the

organ along an arc of a circle whose radius is represented by the renal pedicle (fig. 1544). The latter becomes elongated, the artery more so than the vein, thus allowing of still further movement. Other factors which have been held responsible for the condition include the wearing of unscientific corsets which displace rather than support the abdominal organs; constipation, causing drag on the peri-renal fascia by a loaded cæcum; repeated trauma, such as weight lifting; and severe trauma from falls or blows.

Symptoms and Signs. There may be none, the movable kidney merely being discovered during the course of a routine examination, which proves that the degree and direction of movement are matters of little importance as neither determines the severity of the symptoms, nor indicates the necessity or otherwise for operation.

If symptoms are present, they may be acute or chronic.

Acute Cases. These are the result of rotation of the kidney around its pedicle (Dietl's crisis), which becomes twisted and the venous return obstructed, resulting in congestion and enlargement of the organ. The ureter also becomes kinked and an intermittent hydro-nephrosis may ensue. Following the attack, a large quantity of sometimes blood-stained urine of low specific gravity is passed, possibly from the emptying of the dilated pelvis, but more probably due to the relief of renal stasis resulting in polyuria.

The attack begins with severe pain in the loin, perhaps following an exertion, and is accompanied by vomiting, a rise in pulse-rate, and slight temperature. Rigidity is, as a rule, well marked, which makes it difficult to palpate the kidney; if seen early in an attack the organ is felt to be mobile, enlarged and tender. After some hours, the pain gradually diminishes and a large quantity of dilute urine is passed, containing a trace of albumen, occasionally blood, and is sometimes accompanied by strangury.

Diagnosis. This condition must be distinguished from ureteric colic due to the passage of a stone, acute cholecystitis, acute appendicitis, and perforated peptic ulcer.

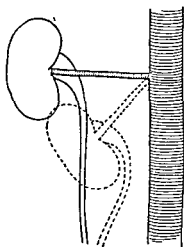


Fig. 1544.—RANGE OF MOBILITY OF MOVABLE KIDNEY.

Chronic Cases. In these there is a continual dragging ache in the loin, sometimes passing into the iliac fossa, worse after exercise and during menstruation, and sometimes relieved by lying down. The patient may herself feel in the abdomen a tumour which is mobile and tender. Often there is an associated neurasthenia which produces an exaggeration of all the renal symptoms ; occasionally, however, the movable kidney may initiate this condition by continual drag on the sympathetic centres in the abdomen.

Diagnosis. This is made by palpation of the kidney during inspiration. The organ is usually tender and in marked cases can be pushed freely about the right side of the abdomen. After expiration, the kidney can be squeezed back into the loin with a characteristic jerk which produces a sickening feeling. In many cases the mobile kidney is merely part of a generalised visceroptosis, and this fact must always be borne in mind.

Treatment. This may be expectant, palliative or operative.

Expectant. In most cases in which a movable kidney is discovered accidentally during a routine examination, and in many cases in which symptoms are slight, no mention of the fact should be made to the patient and no treatment should be advised.

Palliative. This consists of rest, the increase of the amount of intra-abdominal fat by suitable diet, and above all the adoption of every possible method of increasing the intra-abdominal pressure, such as exercises which improve the tone of the abdominal musculature, and the wearing of a suitable abdominal support, such as a Curtis or Spencer belt.

Operative. This is on the whole most unsatisfactory. It is definitely contra-indicated (1) when generalised visceroptosis is present ; (2) when marked neurasthenia exists ; and (3) when the symptoms of movable kidney are not relieved by rest.

Nephropexy (see page 2835).

INJURIES

The majority of injuries of the kidney in civil life are subcutaneous and due to run-over accidents ; to crushes, as between buffers ; or in exceptional circumstances, to a severe blow on the loin.

Symptoms and Signs. (1) Slight cases—as in (2) below (without laceration of the renal capsule). Following an injury there is pain in the loin, with hæmaturia, and sometimes frequency and dysuria. Ureteric colic may occur from the passage of blood clots. Tenderness and rigidity are felt over the kidney, but no swelling.

The hæmaturia usually ceases in a few days, but may be followed by pyuria due to infection of the damaged kidney by the bacillus coli.

Treatment. Light diet, plenty of fluid, attention to the bowels, and rest in bed until the urine is free from blood and pus is all that is required. Urinary antiseptics, such as hexamine 10 grs. before and an acid mixture after meals are given to combat infection.

(2) Severe cases—(with laceration of the renal capsule). Shock is always a marked feature, and is followed by nausea and vomiting; bleeding occurs, either into the perinephric tissues with formation of a gradually increasing swelling in the loin, or into the peritoneal cavity from laceration of the peritoneum. The latter is especially liable to occur in children owing to the lack of perinephric fat. If the laceration extends into a calyx, extravasation of urine will follow. Hæmaturia, with or without ureteric colic from passage of blood clots, is the rule and may be profuse, or may lead to blocking of the ureter, when clearing of the urine will coincide with marked increase of the swelling in the loin. Hæmaturia is also absent if the ureter is torn across. Clotting may occur in the bladder and give rise to retention of urine. Secondary infection of the perinephric hæmatoma may occur, especially if extravasation of urine is present, with formation of a perinephric abscess. General symptoms of infection soon follow, such as rise in temperature and pulse-rate, rigors, increased pain in the loin, etc. Pain is present over the swelling with rigidity of the overlying muscles. With intra-peritoneal bleeding the symptoms of peritonitis soon dominate the picture. Concomitant injury to other organs may be present.

Treatment. In moderately severe cases, conservative treatment may be employed for a time, the patient being at absolute rest in bed and the loin strapped. If any signs of infection occur, operation should be resorted to without delay.

In severe cases, exploratory operations should be carried out as an emergency, the kidney being exposed by the lumbar route and a search made for the bleeding point; but the method of treatment will depend on the condition found.

Primary nephrectomy may be necessary, but in many cases the bleeding can be stopped by gauze packing or by suturing a lacerated renal cortex after the insertion of a strip of muscle. If the pelvis of the kidney is distended, it should be incised and drained. Intra-peritoneal bleeding or the presence of peritonitis necessitates the opening of the peritoneum and an exploration of the abdominal contents, some of which also may be injured.

HYDRONEPHROSIS

Hydronephrosis is a chronic distension of the pelvis and calyces of the kidney by urine, accompanied by absorption of some of the renal parenchyma and an interstitial fibrous change in the remainder, so that finally the organ becomes converted into a large thin-walled, lobulated sac, containing urine of low specific gravity though, in some cases, the kidney may be actually smaller than normal. It is never caused by complete obstruction to one ureter, as this gives rise to atrophy of the kidney.

The condition may be unilateral or bilateral.

Causation. (a) *Partial or intermittent obstruction* which raises the urinary tension in the pelvis of the kidney. This may be congenital or acquired and may occur in some part of the ureter, giving rise to unilateral hydronephrosis, or in the urethra, when both kidneys will become affected and bilateral hydronephrosis ensue.

Ureteric obstruction may be caused by conditions within the lumen of the ureter, e.g. stone, growth or blood clot; changes in its walls, such as stricture, pin-hole ureteric orifice, ureterocele, or congenital valves or folds; pressure or involvement of its wall from without, due to growths (commonly of the uterus), pelvic suppuration, adhesions, or aberrant renal vessels; and torsion or kinking of the ureter from a mobile kidney.

Urethral obstruction may be due to phimosis, pin-hole external urinary meatus, stricture, prostatic obstruction, or rarely to a congenital fold or diaphragm.

A bladder filled by a stone or growth, or the seat of marked chronic cystitis may give rise to pressure on, or stenosis of, one or both ureteric orifices.

(b) *Chronic genital infection.* In a large number of cases no evidence of obstruction can be found in any part of the urinary tract,

but on examination the genital apparatus reveals chronic prostatitis or vesiculitis in the male, and chronic cervicitis, often with a marked cervical erosion, in the female.

Winsbury-White, by injecting the cervixes of rabbits, has demonstrated lymphatic spread forwards to the bladder neck giving rise to chronic trigonitis, and upwards along the lymphatics of the posterior abdominal wall to the kidney. Chronic infection from the genital and lower urinary tract on reaching the kidney in this way at first sets up a condition of atonic dilatation of the pelvis and upper ureter. This may be followed by lengthening and redundancy of the tube, allowing some degree of kinking to occur at the pelvi-ureteral junction. Continuance of the inflammation brings about fibrosis, which fixes the kink by adhesions between the outer walls of the pelvis and ureter with consequent narrowing of the aperture.

Both the stages of atonic dilatation and pelvi-ureteral kinking are well seen by pyelography which should always be carried out in patients suffering from frequency and dysuria and some degree of renal aching.

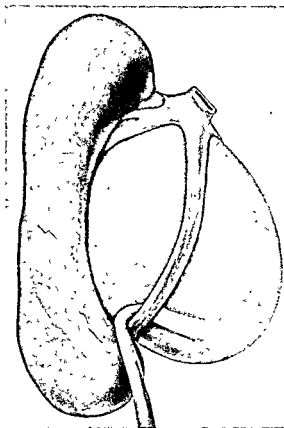


Fig. 1545.—HYDRONEPHROSIS OF PELVIC TYPE. THE URETER IS OBSTRUCTED BY THE NORMAL INFERIOR BRANCH OF THE RENAL VEIN, OVER WHICH THE DILATING PELVIS HAS PASSED FORWARD, DRAGGING THE URETER WITH IT IN ITS PROGRESS.

(St. Paul's Hospital Museum.)

Pathological Types. (1) *Pelvic Type* (figs. 1545 and 1546). In this variety, which usually follows upper urinary tract obstruction, the distension mainly involves the pelvis which communicates with the calyces by relatively large openings. There is some absorption of the renal substance in each calyx which shows some degree of knobbing in a pyelogram. The pelvic type is comparatively more favourable to deal with during the early stages, as less destruction of the actual kidney occurs.

The subsequent progress of the condition has been shown by Winsbury-White to be as follows: The pelvis increases in size, and backward extension being impossible for anatomical reasons, the sac forces its way forwards between the leash of renal vessels, dragging the ureter with it, which becomes kinked over the lowest arterial or venous branch, and results in increased ureteric obstruction. This vessel is



Fig. 1546.—ASCENDING PYELOGRAM. HYDRONEPHROSIS: PELVIC TYPE.

often erroneously described as an aberrant renal "artery," and held responsible for the production of the hydronephrosis; actually it has nothing whatsoever to do with its formation during the early stages, although contributing markedly to its subsequent development once kinking of the ureter has occurred over it.

(2) *Renal Type* (figs. 1547 and 1548). In this variety, usually the result of lower urinary tract obstruction, there is only a moderate

amount of dilatation of the pelvis, which communicates by relatively small openings with the calyces, the degree of dilatation of which depends upon the amount of absorption of the renal substance. The exterior of the kidney becomes markedly lobulated, each lobule corre-



Fig. 1547.—HYDRONEPHROSIS. RENAL TYPE. (Operation specimen, St. Paul's Hospital Museum.)



Fig. 1548.—ASCENDING PYELOGRAM. HYDRONEPHROSIS. RENAL TYPE.

sponding to a dilated calyx. This type is comparatively less favourable to deal with owing to the great amount of damage which has often been done to the actual kidney substance.

Symptoms and Signs. There are two clinical types of hydronephrosis which depend on whether the causal condition is constant or variable. If constant, as, for example, obstruction due to ureteric stricture or fibrosis of the pelvi-ureteral junction, the symptoms are those of the causal condition with often none referable to the kidney, with the exception perhaps of some renal aching (fig. 1549).

Later there may appear a cystic swelling in the loin which has the characteristics of a renal tumour, and which may eventually become so large as to fill the whole of one side of the abdomen.

In unilateral cases there is, as a rule, no alteration in the quantity or quality of the urine secreted, owing to compensatory hypertrophy of the opposite kidney.

In bilateral cases it is rare for a renal swelling to be felt on both sides, as before this occurs the patient develops symptoms of renal insufficiency, such as headache, thirst, loss of appetite and vomiting, and also presents a dry tongue and skin. The urine is increased in quantity, is pale, of low specific gravity from diminution of urea and salts, and contains a trace of albumen.

In both unilateral and bilateral cases infection and stone formation are common complications.

If a variable factor, such as a stone in the ureter, is the causal condition, an *intermittent* type of hydronephrosis is produced, which is characterised by the appearance of a painful renal swelling often preceded by an attack of renal colic. After a few hours or days the pain ceases and is followed by the passage of a large amount of

dilute urine and the disappearance of the tumour. Hæmaturia may occur if the attack is severe.

Diagnosis. In intermittent hydronephrosis the symptoms usually draw attention to one or other kidney, but in other cases the condition is only discovered by feeling a cystic swelling in the loin, having the characteristics of a renal tumour.

Routine examination may discover a lower urinary or genital factor; cystoscopy may show a pin-hole orifice or some vesical cause of ureteric obstruction; intravenous indigo-carmin will be delayed on the affected side. Ureteric catheterisation may be impossible owing to ureteral obstruction. Intravenous pyelography, in most cases,

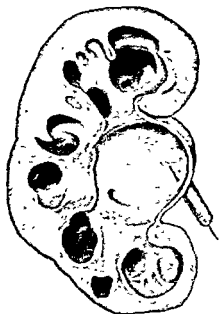


Fig. 1542.—HYDRONEPHROSIS DUE TO STENOSIS OF PELVICUTERINE JUNCTION. THE RENAL PELVIS WAS KINKED OVER THE NORMAL INFERIOR BRANCH OF THE RENAL VEIN.

(St. Paul's Hospital Museum.)

establishes the diagnosis and assesses the functional capacity of the opposite kidney, but if the condition is very advanced, no shadow may be obtained on the affected side, when an ascending pyelogram must be carried out (fig. 1550).



Fig. 1550.—DOUBLE ASCENDING PYELOGRAM. ADVANCED HYDRO-NEPHROSIS ON RIGHT SIDE. EARLY HYDRONEPHROSIS ON THE LEFT.

Treatment. This consists of: (1) The removal, if practicable, of the cause, and (2) the treatment of the hydronephrosis itself. Both depend on an exact knowledge of the conditions present, based on the complete urological examination of the patient.

Removal of the Cause. In a mild degree of unilateral hydronephrosis and in bilateral cases, where prostatic or urethral obstruction exists, the cure of the causal condition may be the only necessary step in the treatment. A urethral stricture is dilated, prostatic obstruction relieved, and any bladder condition dealt with. Chronic infections of the prostate or vesicles and cervix are eradicated.

A pin-hole ureteric orifice is slit up by diathermy through a cystoscope, and a stricture of the ureter dilated with gradually increasing sizes of ureteric bougies. A calculus in the ureter is removed and a movable kidney anchored in place by nephropexy.

Treatment of the Hydronephrosis. In mild unilateral cases and in most bilateral ones, no treatment is indicated other than the removal of the cause if possible. The subsequent progress of the kidney is observed by periodic pyelograms, estimations of the renal function, and any changes in the patient's symptoms.

In severe unilateral cases in which the function of the opposite kidney has been proved to be satisfactory, and especially if complications such as infection or stone formation have supervened, primary nephrectomy should be carried out. In moderately advanced unilateral cases in which investigation proves that there is a reasonable hope of recovery of the renal function, an attempt may be made by operation to restore the renal pelvis to normal proportions and to construct a new pelvi-ureteral junction of adequate size in the most dependent position.

The prognosis depends to some degree on the amount of atony of the pelvis which is readily estimated by a comparison of the intravenous and ascending pyelograms. A marked difference in the size of the pelvic shadows indicates that the power of contraction is still present and is an indication for a conservative operation.

von Lichtenberg's Plastic Operation (see page 2841).

INFECTIVE CONDITIONS OF THE KIDNEY

Pyrogenic infections of the kidney may be divided into three groups according to whether the cavity, the substance, or the exterior is mainly affected.

(a) *The Cavity.* Inflammation of the lining membrane of the pelvis and calyces is termed *pyelitis*. If the adjacent renal tissue is involved as well, the condition is termed *pyelonephritis*. When dilatation of the pelvis and calyces, due to some obstructive cause, is super-added, the distended suppurating kidney is known as a *pyonephrosis*. The same term is applied to a hydronephrosis which has become secondarily infected.

Calculous pyonephrosis is a pyonephrosis in which stones have formed, or which has arisen as a complication to a pre-existing renal calculus.

(b) *The Substance.* Inflammation can attack the cortex of the kidney, with formation of a *renal abscess* which may be single or multiple. In some cases the infection may spread to the calyces and pelvis and result in pyelonephritis, or may burst through the capsule and cause a perinephric abscess.

(c) *The Exterior.* *Perinephritis* is inflammation occurring in the peri-renal fat which surrounds the kidney, converting it into a layer of inflammatory tissue, resulting in adhesions to neighbouring structures.

Perinephric abscess (or acute perinephritis). This name is given to pus formation round the kidney, and may be a secondary extension of suppuration occurring in neighbouring organs, such as the kidney (25 per cent), gall-bladder, appendix, etc., or be primary and occur during the course of an infectious fever or as a complication of distant foci of infection, such as tonsillitis, boils or carbuncles.

METHODS OF INFECTION

Infection may reach the kidney in three ways: From the blood stream (primary or hæmatogenous); from the lower urinary or genital tracts (secondary or ascending); or by direct spread from neighbouring organs.

Hæmatogenous infection can attack any part of the kidney; ascending infection usually attacks the cavity; while direct spread from other organs, as a rule, attacks the exterior.

PYELONEPHRITIS

(a) *Aseptic Pyelonephritis.* This variety of pyelonephritis, as its name implies, is due to non-infective causes, such as the excretion of irritating substances in the urine or back pressure from lower urinary obstruction.

Symptoms and Signs. These are usually mild, and include slight aching in one or both loins, thirst, loss of appetite and weight, and frontal headaches. The tongue is dry, the temperature is a little

below normal; the kidneys are not palpable or tender. The urine is pale and of low specific gravity, but is free from all abnormal constituents. Polyuria is present.

Treatment. This consists of removal of the cause after careful complete urological examination (fig. 1551) as, if neglected, chronic suppurative pyelonephritis may develop.



Fig. 1551.—ASCENDING PYELOGRAM. MILD CHRONIC ASEPTIC PYELO-
NEPHRITIS OF UPPER GROUP OF CALYCES. MIDDLE AND LOWER GROUPS
NORMAL.

(b) *Infective Pyelonephritis. Bacteriology.* The organisms responsible for this condition in order of frequency are: *B. coli*, staphylococci, streptococci, *B. proteus*, and *B. pyocyaneus*. As a rule the *B. coli* exists in pure culture, although mixed infections may occur.

The urine is acid in pure *B. coli* and streptococcal cases, but undergoes ammoniacal decomposition if staphylococci or *B. proteus* are present.

Pathology. The appearances of the kidney vary with the stage of the disease and the virulence of the infecting organism.

In mild acute cases the organ is enlarged and engorged with blood, and on section resembles the changes seen in the toxic nephritis of some specific fevers. Recovery is the rule, and may be complete except for an increased liability to a subsequent attack.

In more severe cases multiple hæmorrhagic abscesses and areas of necrosis occur in the renal tissue which, if extensive, may produce small elevations which can be seen on the surface of the kidney.

Secondary cystitis occurs in hæmatogenous pyelonephritis, but is already present in the ascending type.

In chronic cases scattered abscesses may still be present, and are surrounded by areas of fibrosis with destruction of the glomeruli and tubules. Marked perinephritis may occur with the formation of dense adhesions between the kidney and surrounding structures.

(1) *Acute Primary or Hæmatogenous Pyelonephritis.* This may occur at any age, but is more common in children, in whom the pelvis is mostly affected. In adults it occurs chiefly in women, especially during pregnancy, and usually attacks the right side. It may arise during the course of a fever, but usually a source of infection is present, such as the bowel (chronic constipation), tonsillitis, boils, or carbuncles.

Symptoms and Signs. Mild Cases. Prodromal symptoms of headache, lassitude, and loss of appetite with exaggeration of an habitual constipation precede acute pain in one or both loins, with nausea and a rise of temperature to about 103° , which may follow a rigor.

There is rigidity and tenderness over the kidney which, although enlarged, is rarely palpable. After some hours, frequency of micturition becomes marked, and there may be some dysuria and, very occasionally, hæmaturia.

The urine, at first unaffected, later becomes pale, of low specific gravity and hazy, and swarms with organisms. The amount of pus varies considerably. Some albumen is present.

After a few days the pain and fever diminish, and the urine becomes clearer; all symptoms disappear after about ten days. The urine, however, may contain organisms for some time, and energetic treatment must be directed to the kidney to bring about a cure.

Severe Cases. In this type the symptoms are similar but much more severe, and the patient looks and feels very ill. The prodromal symptoms are quickly followed by a rigor which may be repeated,

and the temperature rises to 105° or more. There is very acute pain in one or both loins, together with vomiting, great thirst, sweating, and collapse.

Rigidity is marked, but after a few days an enlarged and tender kidney can usually be felt. Leucocytosis up to 20,000 may occur. The urine is scanty, acid, and contains bacteria, pus, blood, casts, and epithelial cells from the renal pelvis and bladder. It may vary considerably from day to day from temporary blockage of the pelvi-ureteral junction. When this occurs an almost clear urine coincides with an increase of pain and temperature, and is followed by profuse pyuria with remission of the general symptoms.

After two or three weeks the disease may subside, but sometimes recurs repeatedly owing to exacerbations in the affected kidney or to fresh infection of the opposite one, as shown by repeated rigors and a high swinging temperature. Anorexia is marked and the patient wastes rapidly.

When the acute symptoms subside the urine begins to improve, but the bacilluria may persist for months.

In very severe cases death may occur during the first week from septicæmia, or from uræmia, with drowsiness, coma, abdominal pain and rigidity, vomiting, and scantiness or complete suppression of urine. In others, especially if the disease is bilateral, after a continual series of relapses, uræmia may supervene on prolonged renal suppuration.

Diagnosis. Acute primary pyelonephritis may easily be confused with some acute intra-peritoneal emergency, such as acute appendicitis or a perforated peptic ulcer, but the more localised tenderness and rigidity in one or both loins, especially marked in the post-renal angle, the very high temperature which is out of all proportion to the pulse, the presence of urinary symptoms, and the character of the urine, should make the diagnosis clear.

Treatment. Mild Cases. The patient is put to bed, placed on a milk diet, and given large quantities of barley-water, whey, and citrated milk to drink. Large doses of alkalis (potassium citrate 30 grs., with sodium bicarbonate 30 grs.), are prescribed four times a day. Hot fomentations or turpentine stupes are applied to the loin and dry cupping may be tried.

The bowels need careful attention, as constipation is a marked factor, and nightly aperients followed by salts in the morning are recommended.

An autogenous vaccine sometimes alleviates the symptoms, but neither cuts short the attack nor diminishes the bacilluria.

Severe Cases. The treatment is similar to the above, but 25 cc. of anti-serum should replace the vaccine and be given for three days, together with 20 grains of calcium lactate three times daily, to prevent serum rashes and joint pains.

The bladder should be washed out daily, especially in bilateral cases, with acriflavine 1 in 8000. The passage of ureteric catheters and lavage of the renal pelvis with a 1 in 2000 solution of the same antiseptic may give good results. In some cases a large ureteric catheter should be tied in on one or both sides and the kidneys washed out three or four times a day.

Operative treatment should not be lightly undertaken, especially while the disease is acute. If fever continues for three or four weeks and the condition is proved by cystoscopy and ureteric catheterisation to be unilateral, nephrectomy is indicated, when the kidney will be found to be riddled with small abscesses.

If suppression of urine occurs, nephrotomy with drainage of the pelvis must be carried out, and it is sometimes remarkable how quickly urinary secretion is re-established with improvement of symptoms, should the patient survive the operation (mortality 30 per cent).

Secondary nephrectomy may be necessary at a later date.

(2) *Acute Secondary or Ascending Pyelonephritis.* This is due to an extension of infection from the lower urinary or genital passages, and may be the last phase of many chronic diseases of the bladder and urethra, or it may follow instrumentation or operation on these structures, when it is termed "surgical kidney."

For a time the condition may be unilateral, but it invariably becomes bilateral. Predisposing causes include urethral and prostatic obstruction, vesical or ureteric stone and vesical growths. Intractable secondary cystitis with residual urine occurs sooner or later, organisms usually being introduced by instrumentation, and the infection spreads up the lymphatics surrounding the ureters to one or both kidneys, which may become studded with miliary abscesses.

Symptoms and Signs. Severe Cases. During the course of some disease of the lower urinary or genital tract, and usually following instrumental or operative interference, there is a severe rigor followed by a rise of temperature to 103° or 105°, which may remain high or be swinging with recurrent rigors. The patient becomes drowsy and

listless, and complains of headache, backache, nausea, and intense thirst. The tongue is dry, red, and glazed, and may eventually become coated with brown or black fur. Herpes labialis is common. Attacks of hiccough alternate with vomiting and cause increasing distress. Abdominal distension, rigidity which is more marked on one side, and absolute constipation are present. Tenderness is present over both kidneys, but after a time becomes more pronounced on one side. Partial or complete suppression replaces the pre-existing polyuria.

The symptoms gradually increase, uræmia, dyspnoea, and Cheyne-Stokes respiration may be present, and the patient becomes comatose and dies.

Mild Cases. The symptoms are similar to the above, but after a variable time the temperature falls, the urinary secretion recommences, flatus is passed, and the acute symptoms gradually subside.

Treatment. The possibility of lighting up an acute ascending pyelonephritis must always be borne in mind when any instrumental or operative interference is planned for a chronic condition of the lower urinary tract. The passage of a catheter or cystoscope, for instance, must be accompanied by rigid aseptic precautions and the utmost gentleness. If, in spite of these, the infection becomes established, general treatment is undertaken as for hæmatogenous pyelonephritis, but is much more disappointing in its results.

Operative treatment must be carried out at a much earlier stage, and should be directed primarily towards the relief of lower urinary tract obstruction by early suprapubic cystotomy. Should the patient survive, the cause of obstruction can be removed at a later date.

Nephrotomy is indicated if suppression occurs. Owing to the large preponderance of bilateral cases, nephrectomy can but rarely be performed.

(3) *Chronic Suppurative Pyelonephritis.* Chronic pyelonephritis may be the result of a pre-existing acute pyelonephritis of either the hæmatogenous or the ascending type, or may become superimposed on an aseptic chronic pyelonephritis.

Hæmatogenous or primary chronic pyelonephritis is more commonly unilateral, but the reverse applies to the ascending or secondary variety.

Symptoms and Signs. In well-marked cases the patient has a sallow complexion, a harsh dry skin, and dry mouth, throat and tongue, the latter in time becoming glazed, red and cracked. There is frontal

headache, drowsiness, indigestion, nausea, and gradual loss of appetite and weight.

The amount of urine is increased and is pale, of low specific gravity (under 1006), usually faintly acid or neutral, and contains pus and organisms. Frequency and dysuria occur and, if the chronic pyelonephritis is of the ascending type, symptoms and signs of a lower urinary tract condition are usually present. The infection may persist for years, but eventually the kidney is destroyed. Stone formation may occur.

Diagnosis. This is made by a consideration of the history and symptoms and a complete urological investigation. Routine examination may reveal obstruction. By cystoscopy an intravesical cause, if present, will be seen. Ureteric catheterisation will show whether a stricture is present; bacteriological examination of the specimens will prove a unilateral or bilateral condition, and indigo-carminc indicate the degree of renal damage.

Intravenous or ascending pyelography will exclude ureteric or vesical stone, and demonstrate the exact condition of the renal pelvis and calyces (fig. 1552). Should no urinary or genital cause be found, a diagnosis of primary chronic pyelonephritis is made.



Fig. 1552.—ASCENDING PYELOGRAM SHOWING CHRONIC PYELONEPHRITIS ON THE RIGHT SIDE.

Treatment. When chronic obstruction and sepsis exist in the lower urinary or genital passages, every effort should be made to eradicate these before secondary chronic pyelonephritis occurs. When once established, the greatest care should be taken with all instrumental or operative measures directed towards the cause of the condition. Thus preliminary catheter drainage, combined with regular irrigation of the bladder, is essential if obstruction is present. Fluids, diuretics and urinary antiseptics should also be given. Prostatectomy must, without exception, be performed in two stages, the interval between the two being entirely determined by the general condition of the patient and the renal function tests.

In severe primary chronic pyelonephritis, if examination shows that the disease is unilateral and that the opposite kidney is sound, nephrectomy is indicated.

PYELONEPHRITIS OF PREGNANCY AND THE PUERPERIUM

Pyelonephritis of pregnancy, often described as pyelitis of pregnancy, in no way differs from other varieties of this disease, having similar bacteriology, pathology and symptoms. In over 90 per cent of cases it is unilateral and attacks the right kidney, and most frequently appears about the 5th month. During pregnancy two predisposing factors are commonly found: (a) urinary stagnation, and (b) urinary infection.

(a) *Urinary stagnation* is produced by the hypertrophy and swelling of the vesical mucous membrane, which is part of the general hypertrophy of the pelvic organs, and which may produce marked obstruction of the ureteric orifices. This obstruction causes dilatation of the upper urinary tract, though in most cases it is restricted mainly to the right ureter and renal pelvis. The unilateral nature has been ascribed to pressure on the right ureter from the increasing growth of the foetus, and some measure of proof is afforded by the frequent response of pyelonephritis to the adoption of the Trendelenburg position alone, which relieves the pressure.

(b) *Urinary infection.* *Bacillus coli* bacilluria in pregnancy has been found in 90 per cent of cases, though its source is a matter of much dispute. The fact that the colon bacillus can be demonstrated in the lymphatics surrounding the ureter indicates that the infection may be an ascending one from the cervix, though some observers maintain that the bacilluria is due to a mild *bacillus coli* septicæmia, with excretion of these organisms by the kidneys. Whatever view be adopted there is no doubt that the combination of infection and urinary stagnation is responsible for the high incidence of pyelonephritis during pregnancy. Should an attack occur and subside, an acute recurrence during the same pregnancy is uncommon, and this may be ascribed to the fact that once the urinary resistance to a *bacillus coli* infection is established, an immunity to further acute exacerbations is the rule, although the pyuria and bacilluria still continue. An acute flare up, however, is only too commonly seen during the puerperium unless the most stringent measures are adopted to secure the complete

eradication of the infection. Pyelonephritis of the puerperium is always secondary to an attack during pregnancy, though this may have been so mild as to escape recognition, and may give rise to a severe bacillus coli septicæmia, sometimes complicated by endocarditis and pleural effusion which prohibit surgical intervention. Medical treatment, however, is not so hopeless as the condition would suggest, as the factors responsible for its production are disappearing.

Symptoms. An attack of pyelonephritis of pregnancy usually occurs about the 5th month. The patient looks and feels ill and she is seized with acute pain, nearly always in the right loin, accompanied by rigors and shivering, frequency and dysuria, and some constipation and vomiting.

An important point in the diagnosis is the combination of a raised temperature and a relatively low pulse, and routine examination of the urine is essential to avoid a mistaken diagnosis of appendicitis. In some very acute cases the local signs are overshadowed by the graver condition of bacillus coli septicæmia, but fortunately this complication is a rare one.

Treatment. (1) *Prophylactic.* Routine bacteriological examination of the urine constitutes a most important part of ante-natal care, and should never be omitted in any circumstances.

Infection, if present, must be combated by the administration of large quantities of fluids, alkalis, and local treatment to the cervix, which must necessarily be confined to ichthyol and glycerine packs, as otherwise abortion may be brought about.

(2) Once pyelonephritis has occurred, the induction of premature labour is only indicated in severe bilateral cases. In unilateral infections, rest in bed is combined with strict attention to the bowels and the prophylactic treatment just described, together with the application of hot fomentations to the loin. When the temperature subsides, hexamine before and an acid mixture after meals are substituted for alkalis, but if it persists the patient should be placed on mandelic acid (see page 2782). In more severe cases an attempt should be made to diminish the degree of infection present in the upper urinary tract by frequently washing out the renal pelvis through a ureteric catheter which may be left *in situ* for several days.

The later in pregnancy the pyelonephritis develops, the worse is the prognosis, and in some cases nephrotomy or even nephrectomy may have to be considered.

PYELITIS

Pyelitis is in reality a sub-acute or chronic type of pyelonephritis in which the brunt of the inflammation falls on the lining membrane of the pelvis and calyces, and there is little involvement of the renal substance.

The method of infection, bacteriology, and varieties are the same as in pyelonephritis, and both hæmatogenous and ascending types can occur. In some cases a stone or growth may be present in the renal pelvis, but in the majority no such predisposing cause can be found.

Pathology. In acute pyelitis the lining membrane of the pelvis and calyces is congested, and may become thickened and show areas of hæmorrhage and superficial ulceration.

In chronic pyelitis the pelvis becomes thickened and the mucous membrane opaque, often with a cystic or granular appearance.

The condition is usually unilateral, but may be bilateral. Primary or secondary cystitis is present.

Symptoms and Signs. These are, as a rule, overshadowed by the symptoms of cystitis which may be secondary to the pyelitis or to some lower urinary cause. Frequency, dysuria, and occasionally terminal hæmaturia are accompanied by a rise of temperature to 100°, and there is a mild constant ache in one or both loins; there may also be tenderness on palpation. The kidneys are not as a rule enlarged.

The urine is increased in amount, of low specific gravity, opalescent, and contains organisms, pus and epithelial cells. Casts are absent. In the common *B. coli* infection it is acid and has a fishy smell. A thick creamy layer of pus separates out at the bottom of a urine glass on standing. The genital tract may show evidence of chronic infection, such as cervicitis in the female and prostatitis in the male, and urethral stricture or prostatic obstruction may be present.

Cystoscopic examination reveals cystitis which, if secondary to the pyelitis, may be more marked on one side, with congestion and reddening of the corresponding ureteric orifice. The efflux is cloudy, more prolonged, and more frequent.

Ureteric catheterisation will locate the disease to one or both kidneys. In pyelitis uncomplicated by stone, intravenous pyelography is characterised by a very faint or even a complete absence of the shadow of the opaque medium in the renal pelvis and calyces, although

as a rule a good cystogram is obtained. This is explained partly by a depression of the renal function, whereby the concentration of uroselectan B is diminished, and partly by an increased rate of emptying of the renal pelvis brought about by inflammatory irritation. Ascending pyelography shows no abnormality of either pelvis or calyces.

Diagnosis. This is made by a consideration of the history, the symptoms, and by a complete urological examination. Absence of a lower urinary or genital cause will suggest a primary or hæmatogenous pyelitis. Pyelography will show the features already described.

Treatment. In ascending pyelitis, the primary cause in the lower urinary or genital tracts must be eradicated; in the hæmatogenous variety any predisposing condition in the kidney, such as a stone, must be removed.

Large doses of alkalis, fluids and waters, such as Contrexéville or Vittel, should be administered until the temperature becomes normal and bladder symptoms have subsided, after which the alkalis should be alternated with acids and hexamine. If intravenous pyelography is carried out at this stage the radiographic shadow will be found to be normal in outline, density, and rate of appearance and disappearance. In resistant cases the bladder should be washed out daily with acriflavine 1 in 8000, and the renal pelvis weekly with a 1 in 2000 solution of the same drug through a ureteric catheter.

In chronic cases an autogenous vaccine may be tried, but the results are disappointing.

THE KETOGENIC DIET¹

THE method of treating urinary infections by antiseptic drugs administered either by the mouth or by intravenous injection has often proved to be a disappointing failure. This is probably due to the fact that it is extremely difficult to render the urine bactericidal by this means. Sub-acute and chronic *B. coli* infections are particularly resistant to the ordinary drug methods and to local treatment of the urinary tract. In such cases the ketogenic diet frequently proves successful and should always be given a thorough trial.

¹ This article on Ketogenic Diet is included purely for academic reasons. This form of treatment has now been superseded by the use of Mandelic Acid (see page 2782). EDITOR.

The ketogenic diet was originally based on observations that urine from patients who were excreting ketone bodies did not putrefy after standing exposed for several days in a warm room. Apparently such urine contained bactericidal properties. Experiments have since proved that, in order to produce a bactericidal effect, not only must there be the presence of ketone bodies in an acid urine, but that there must be not less than a certain percentage of oxy-butyric acid. Fuller believes that the growth of bacteria is inhibited chiefly by the oxy-butyric acid and that this acid becomes more active as the pH of the urine decreases. For example, urine containing 2 per cent of oxy-butyric acid is bactericidal when the pH of the urine is 5.5, but non-bactericidal if of an alkalinity of pH 7.4.

The ketogenic diet was first used by Helmholtz and Clarke of the Mayo Clinic, and later by Wilson and Dunlop in England. The treatment consists in prescribing a diet with a high proportion of fats and a low proportion of carbohydrates, and if the pH of the urine does not fall below 5.5, oral medication is necessary to increase its acidity. For this purpose, ammonium chloride or ammonium nitrate in the form of enteric-coated tablets may be used. A total of twelve tablets of 0.5 g. (or $7\frac{1}{2}$ grains) each must be administered in four or six doses during the day.

The proportion of fat in the ketogenic diet should not be less than 3 to 1: that is, the amount of fat should equal three times the amount of protein and carbohydrate combined. If this does not produce ketosis, the carbohydrates should be diminished by 5 g. every three days. The diet must be calculated strictly on a quantitative basis and must be different for every patient. The co-operation of a trained dietician is desirable, and the total calorific requirements for a patient of a given weight must be estimated daily. The normal adult requires approximately 16 calories per pound of body weight, but 25 calories must be allowed for a child. An average woman weighing nine stone would therefore require a minimum of 2,016 calories per day. The amount of fat may be calculated in grams as 10 per cent of the total calories required—hence the above-mentioned woman would require about 200 grams of fat on the ketogenic diet. As a man requires from 60–70 grams of protein per day, and a woman from 55–65 grams, the proportions for this patient, allowing for a surplus above the calculated minimum of calories needed per day, might be as follows: Fat 225 g., protein 60 g., leaving only 15 g. for carbohydrates. This diet yields about 2,400 calories per day.

The larger part of the fat is best given in the form of butter and

fresh 40 per cent or 20 per cent dairy cream, as these are easily digested and a considerable proportion can be used to advantage in casserole or other French methods of cooking. Cream may also be used in soups, fruit fool, cream moulds (made with cream, gelatine and fruit juice), in ice cream, in tea and coffee, and in plain soda water. Fuller uses a synthetic cream made as follows: Dissolve 1 ounce of soluble white casein (British Drug Houses) in $1\frac{1}{2}$ pints of water, steaming in a double saucepan. Strain through muslin before use. Warm 3 ounces of this solution with a little saccharin, mix with 2 ounces of melted salt-free butter and pump through a cream machine (Pentecreme or Empire type). Ice cream can be made by mixing this synthetic cream with gelatine and eggs and some flavouring, such as vanilla, and freezing in a salt and ice box. Tomato juice or orange juice taken in sips help to overcome the nausea so often experienced with this diet. A day of starvation before the commencement of the treatment and the occasional missing of a meal during treatment assist in the production of ketosis and in the prevention of nausea and vomiting.

It is desirable to supply roughage by means of salads, vegetables and fruits containing less than 5 per cent of carbohydrates. If the patient is not responding well this part of the diet must then be restricted to those foods that contain less than 2 per cent.

The following fruit and vegetables contain less than 2 per cent of carbohydrates (from *The Carbohydrate Contents of Foods*, McCance and Lawrence):

1

Celery.	Artichokes.
Chicory, raw.	Asparagus.
Cranberries.	Black currants, stewed.
Cress.	Cabbage.
Kale.	Cauliflower.
Lettuce.	Cucumber.
Mustard.	French beans.
Rhubarb, stewed.	Gooseberries, stewed.
Ripe olives.	Lemons.
Watercress.	Lemon juice.
	Loganberries, stewed.
	Radishes.
	Runner beans.
	Seakale.
	Spinach.

The following contain more than 2 per cent and less than 5 per cent :

Apples, fresh stewed.	Leeks.
Barcelona nuts.	Loganberries, raw.
Bilberries.	Marrow.
Blackberries, raw or stewed.	Melon.
Black currants, raw.	Pine kernels.
Brazil nuts.	Plums, stewed.
Broccoli.	Pumpkin.
Brussels sprouts.	Raspberries.
Cherries, stewed.	Red currants.
Coco-nut.	Spring onions.
Damsons.	Strawberries.
Endive, raw.	Swedes.
Greengages, stewed.	Tomatoes.
	Turnips.
	Walnuts.

The remainder of the carbohydrates not supplied by the fruit and vegetables should be given in the form of Callard's or Heudebert's reduced biscuits and rolls, or in the form of soya bean rolls. The latter contain a preponderance of fat, are usually disliked by English patients, and have the disadvantage of not keeping long. If it is necessary to reduce still further the amount of carbohydrate, gluten rolls such as those supplied by Heudebert for "Strict Diabetic Diet" should be given.

The protein is given in fish, meat, eggs and cheese. If the patient can digest them, the richer forms of animal protein, e.g. pork, goose, ham, duck, game, salmon, turbot, herring and mackerel, are helpful in quickly producing ketosis on account of their high fat content.

Alcoholic drinks, milk, bread, flour as thickening for gravies and soups, and every form of starchy foods except those described above must be strictly prohibited. For sweetening purposes saccharin or glycerine is useful. Only fruit that is bottled or tinned without syrup may be used. The patient must be warned not to take anything between meals. Fluids should be restricted, as results are obtained much quickly with a more concentrated urine. Not more than 2 pints of fluid should be taken in the 24 hours. This may include tea, coffee, lemonade, plain soda-water, and soups which should be thickened with cream. Alkalis, e.g. potassium and sodium citrates, are forbidden.

Exercise is important in order to aid in oxidation of the fat and so promote ketosis. Open-air exercise is best, and herein lies a difficulty, for it is while the patient is out and about that he is likely to succumb to the temptation of drinks, snacks and sweets. A small amount of sugar taken in this way may retard recovery. Old people do not respond well to the treatment, especially if infirmity prevents sufficient exercise.

The patient should be able physically to stand this change in diet. It has been found, however, that even in cases where there was intolerance for the fatty food followed by anorexia, nausea, vomiting and malaise, ketosis often developed rapidly and with successful results. Ketosis should develop in from 3 to 5 days. After this, a period of from 1 to 3 weeks may be required before cultures made from the urine are free from growth. The patient should be kept on the diet a week longer, and then instructed to return to a normal diet. In cases where the upper part of the urinary tract is involved, several courses of dietetic treatment of two or three weeks each, after fortnightly intervals of normal mixed diet, may be necessary. If, after attention to all essential details, ketosis is not obtained in 12 days, further effort will probably be unsuccessful. Some patients cannot digest extra fats. Some who digest them do not produce ketonuria. Other patients may produce ketone bodies, but not hyper-acid urine, even with the aid of ammonium chloride. This form of treatment is therefore unsuitable for such cases.

The colon bacillus is more sensitive to this type of treatment than any other Gram-negative bacilli found in urinary infections. The bacillus *aerogenes* is the most difficult to eradicate. Helmholtz found it very successful in the treatment of children with both bacillary and coccal types of infection.

Infections of the urinary tract are often secondary to other urological conditions. Obviously, after relieving the acute symptoms, the surgeon must identify and, if possible, remove the primary cause. The ketogenic diet may be used both before and after operation or instrumentation if the temperature is not too high. If the patient has an acid ketone urine, exacerbations of existing conditions will be prevented and there will be less likelihood of the occurrence of new infections after the operation. In cases of acute primary or recurrent pyelonephritis or cystitis, it is necessary first of all to treat the patient in the usual way and to render the urine hyper-acid by means of acidifying drugs until the temperature is reduced and the general symptoms are relieved. The ketogenic diet may then be commenced and the patient allowed to exercise. In chronic infections, even

where the temperature is moderately raised, the treatment can be commenced at once and is often brilliantly successful, the local symptoms disappearing in a few days. Sometimes in these cases the symptoms persist even after the urine becomes clear and microscopically there are no signs of pus. The urine should then be centrifuged and the sediment cultured, when the infecting organism will probably be found. In secondary infections after laparotomy, pelvic operations, post-operative retention of urine, instrumentation such as the passing of sounds and catheters, and after cystoscopy, the ketogenic diet should be tried. It may also reduce or clear up the secondary infection so often found in cases of inoperable cancer or following an attack of gonorrhoea.

Where, as the result of disease, much renal injury has been effected and renal function is poor, ketonuria may not develop, or a sufficiently acid urine may not be secreted to inhibit bacterial growth. The pH of an infected kidney may be round about 7.0, or even less acid, while the normal kidney may be secreting urine of a suitable pH of about 5.0. Cases of chronic nephritis or those with polycystic kidneys often derive benefit from the ketogenic diet.

In cases where ketonuria is produced, together with a suitable pH, and yet the infection does not appear to clear up, or where there are recurrent attacks of cystitis, the surgeon should examine for small hidden chronic abscesses, which may be reinfecting the urine. They should be opened up and the ketogenic treatment continued. If constipation is present, it should be treated until normal free bowel actions are the daily rule.

Daily chemical examinations of the urine for the pH and ketonuria are essential, but bacterial cultures need not be made oftener than three times weekly.

TESTS

(1) Determination of the Hydrogen-ion Concentration.

A fairly accurate measure of the pH can very easily be obtained by means of the D.D.H. capillator, using indicators to cover the range pH 5 to pH 7. A more approximate estimate can be made by adding a drop of indicator to a drop of urine on a white tile. A red or orange colour with methyl red (pH 4.2 to 6.3) indicates a satisfactory acidity (pH 5.0 to 5.5)—a yellow colour shows that the urine is too alkaline. In most cases a good ketosis will produce a sufficient acidity; if it does not within the first 48 hours, acidifying salts, e.g. acid sodium phosphate or ammonium chloride, should be given in large doses.

(2) Determination of the Keto-acids. Modified Rothera test according to Fuller.

To 1 cc. of urine, 0.8 g. of ammonium sulphate, 0.05 cc. of aqueous sodium nitroprusside, and 0.15 cc. of 0.880 ammonia are put in a small tube, well shaken, and placed in a water bath at 20 degrees Centigrade for seven minutes. (The time and temperature must be constant if the results are to be comparable.) If only a pink tint develops, the concentration of aceto-acetic acid in the urine is less than 0.005 per cent (i.e. too little for therapeutic purposes), and further estimation is unnecessary. If a deep purple colour develops, the estimation of the aceto-acetic acid is completed by diluting with water in a tube of $\frac{5}{8}$ -inch bore until the colour matches that of a standard solution contained by a similar tube. Reading off the volume and multiplying by 0.004 gives the percentage concentration of aceto-acetic acid in the urine under test.

The standard colour solution—which was made by comparison with a nitroprusside test of a known concentration of aceto-acetic acid—consists of: 8 cc. of 0.01 per cent methyl violet in alcohol, 2 cc. of a 0.01 per cent basic fuchsin in alcohol, 2 cc. of chrysoidin in alcohol, the mixture made up to 40 cc. with absolute alcohol. It is stable for six months if kept in the dark. The nitroprusside solution should be freshly made every other day and kept in the dark.

KETOGENIC DIET

The following is a specimen diet suitable for a woman weighing 9 stone, giving about 2400 calories per day. The food should be carefully cooked and attractively prepared, and it should be as varied as the season of the year and a skilful cook can provide.

Breakfast : $\frac{1}{2}$ grape-fruit.

2 eggs—or 1 egg and 2 oz. short back rasher bacon.

2 gluten rolls and 1 oz. butter.

1 raw peach, pineapple or apricot, with 3 oz. 40 per cent cream.

Coffee or tea, with 1 oz. 40 per cent cream.

Luncheon : 3 oz. fish cooked in 1 oz. butter.

4 oz. each of three vegetables from the list containing less than 2 per cent carbohydrate; or 12 oz. green salad with dressing made of lemon, olive oil and egg yolk.

Fruit salad (fruits containing not more than 5 per cent carbohydrate), with 3 oz. 40 per cent cream.

Gluten roll, with $\frac{1}{2}$ oz. butter.

Lemonade.

PYONEPHROSIS

A pyonephrosis is a kidney whose pelvis and calyces are distended with purulent urine or pus and whose secreting tissue is being rapidly destroyed by a combination of infection and back pressure. It is described as *open* when the obstruction is incomplete and *closed* when complete. (Tuberculous pyonephrosis is described under "Renal Tuberculosis.")

Pathology. In advanced cases the kidney is divided by a number of septa, which represent all that is left of the degenerating renal tissue, into compartments containing pus (fig. 1553). Marked perinephritis is present, the normal perinephric fat being replaced by a fibro-lipomatous mass, while dense adhesions are formed to the surrounding structures. The kidney may vary in size and be but slightly enlarged or form a lobulated swelling in the loin, which in extreme cases may extend into the iliac fossa and cross the mid-line of the abdomen.

Two varieties of pyonephrosis exist: (a) The first consists of a hydronephrosis in which infection has occurred and which may be either of the pelvic or renal type. In the pelvic type it contains urine having a varying amount of pus. The bulk of the swelling consists of a much ballooned and thickened pelvis, the kidney itself, not much enlarged, being perched on one side of it. In the renal type the pelvis is only moderately enlarged, but the calyces are enormously so, the kidney being converted into a large multilocular sac.

The condition is usually unilateral and commoner in women. Infection is either hæmatogenous or ascends through the lymphatics from the lower urinary or genital tract. The most common organisms are the *B. coli*, staphylococci, and *B. proteus*.

(b) The second variety of pyonephrosis consists of a pyelonephritis in which urinary obstruction has occurred. It is of the renal type just described, and contains mainly pus with very little urine. It may complicate chronic disease of the lower urinary tract, and is more frequent in men. In both varieties primary or secondary calculi (calculous pyonephrosis) may be present.

Symptoms and Signs. The cardinal symptoms of a pyonephrosis are: pain, swelling, fever, and pyuria. These may, to a varying extent, be overshadowed or supplemented by the symptoms of a

pre-existing pyelonephritis, or of an ascending infection from a cystitis complicating disease of the lower urinary or genital tracts.

Pain. There is usually a constant aching pain in one or other loin which is worse at night. Attacks of ureteric colic may occur from the passage of pus and debris.

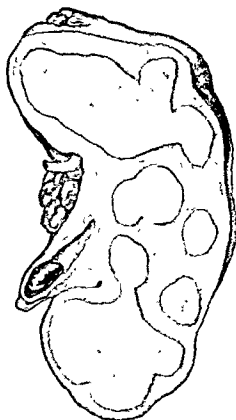


Fig. 1553.—CALCULOUS PYONEPHROSIS.
(St. Paul's Hospital Museum.)

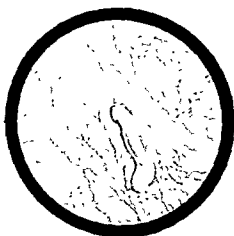


Fig. 1554.—SEMI-SOLID PUS EMERGING FROM
RIGHT URETERIC ORIFICE.

Swelling. A swelling resembling a hydronephrosis is present in the loin, and may vary in size from a tumour which is just palpable to a large mass which occupies most of one side of the abdomen. In addition, it is tender and there is some rigidity of the overlying muscles. It is smooth, firm, and non-fluctuating. Its mobility depends on the amount of perinephritis present, and in cases of calculous pyonephrosis the kidney may be completely fixed.

Fever. There is usually a nightly rise of temperature to about 9° F., but this may be increased to 102° or more if retention of

purulent urine occurs in the kidney from sudden blockage of the ureter.

Pyuria. In an open pyonephrosis the urine is milky and contains a large quantity of pus which, on standing, rapidly sinks to the bottom of a specimen glass. The amount of pus, however, varies with the degree of obstruction present, and attacks of retention of pus in the kidney, from temporary blocking of the ureter, are accompanied by an increase in the size and tenderness of the swelling, a rise of temperature and rapid clearing of the urine. The patient looks and feels ill from the increased septic absorption.

In unilateral closed pyonephrosis pyuria is absent provided the bladder is free from infection.

Diagnosis. This is made by a consideration of the history, the cardinal symptoms mentioned above, and a complete urological examination. Routine examination and cystoscopy will reveal any disease of the lower urinary or genital tracts. Cystitis will be present, and semi-solid pus or purulent urine may be seen to emerge from one or other ureteric orifice (fig. 1554), except in a closed pyonephrosis, when the efflux is absent. The ureteric orifice may be gaping and immobile and its lips swollen or ulcerated, but in many cases it appears quite normal. Indigo-carminc will be delayed or will fail to appear at one orifice, and will provide an estimate of the function of the opposite kidney.

Ureteric catheterisation may localise the infection to one kidney and determine the patency of the ureter.

Intravenous pyelography will usually confirm the diagnosis, the appearances resembling a hydronephrosis, but if a closed pyonephrosis is present, or if the kidney is totally disorganised, no shadow will appear on the affected side. In such cases an ascending pyelogram should be carried out. An intravenous pyelogram will also determine the presence or absence of stones and the condition of the opposite kidney.

Treatment. If the condition is unilateral and the opposite kidney healthy, primary nephrectomy is the operation of choice. Any disease of the lower urinary or genital tracts which might, in time, affect the opposite kidney must be eradicated and every effort made to free the urinary tract from infection.

Under no circumstances should a plastic operation on the renal pelvis be attempted, as failure is certain.

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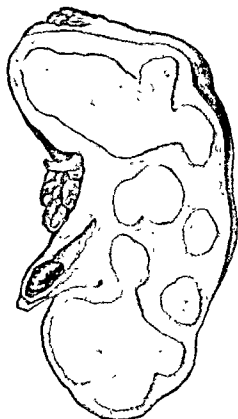


Fig. 1553.—CALCULOUS PYONEPHROSIS.
(St. Paul's Hospital Museum.)

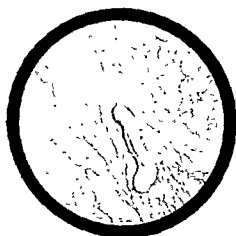


Fig. 1554.—SEMI SOLID PUS EMERGING FROM
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Swelling. A swelling resembling a hydronephrosis is present in the loin, and may vary in size from a tumour which is just palpable to a large mass which occupies most of one side of the abdomen. In addition, it is tender and there is some rigidity of the overlying muscles. It is smooth, firm, and non-fluctuating. Its mobility depends on the amount of perinephritis present, and in cases of calculous pyonephrosis the kidney may be completely fixed.

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Treatment. If the condition is unilateral and the opposite kidney healthy, primary nephrectomy is the operation of choice. Any disease of the lower urinary or genital tracts which might, in time, affect the opposite kidney must be eradicated and every effort made to free the urinary tract from infection.

Under no circumstances should a plastic operation on the renal pelvis be attempted, as failure is certain.

In unilateral cases, in which the life of the patient is in great danger from prolonged septic absorption, preliminary nephrotomy should be carried out, with removal of stones if present, followed by secondary nephrectomy when the patient's condition has sufficiently improved.

In bilateral cases, the only procedure which can be attempted is the removal of any possible cause of the condition followed by palliative measures, such as the regular passage of ureteric catheters and pelvic lavage; but occasionally bilateral nephrotomy must be carried out as a life-saving measure.

PERINEPHRITIS

Perinephritis is a chronic inflammation outside the kidney, but within the perinephric sheath, which causes either a fibro-lipomatous change, whereby the delicate perinephric fat is replaced by coarse nodular fat with tough fibrous intersections, or a fibro-sclerotic change with formation of a thick dense sheath which adheres to and constricts the true renal capsule.

Adhesions, which are most marked in the fibro-sclerotic form, are formed between the kidney and the surrounding structures, such as the colon, duodenum, peritoneum and diaphragm.

The disease is always secondary to some chronic form of renal disease, such as pyelonephritis, pyonephrosis, stone or tuberculosis. The symptoms and signs and treatment are those of the causal disease which may necessitate nephrectomy, but this, especially in fibro-sclerotic perinephritis, may be exceedingly difficult and dangerous.

PERINEPHRIC ABSCESS (ACUTE PERINEPHRITIS)

Although no age is exempt, perinephric abscess occurs most commonly in adult life, and more frequently on the right side than the left. It may be primary or secondary. The primary form may occur if there exists some focus of infection elsewhere in the body, such as tonsillitis, carbuncles, or recurrent boils, or may arise during the course of a specific fever, such as typhoid or scarlet fever, measles, or pneumonia.

The secondary form is due to injury or disease of the kidney in 25 per cent of cases; and in the remainder, to extension of suppuration from neighbouring organs, such as the gall-bladder, appendix, pelvic organs, spine or pleura. Examples of perinephric abscess secondary to the kidney are: (1) The infection of a peri-renal hæmatoma by extravasated urine, following laceration of the kidney.

(2) Extension of suppuration from calculous disease, pyonephrosis or pyelonephritis. (3) Renal abscess or infarct of hæmatogenous origin, rupturing into the perinephric fat.

In primary perinephric abscess, and in secondary perinephric abscess of renal origin, the abscess is usually situated within the perinephric sheath, and may be uni- or multi-locular. Extension may occur downwards along the ureter into the pelvis, or the pus may burst through to the outside of the perinephric sheath, where the other forms of secondary perinephric abscess due to disease of neighbouring organs occur. Three varieties of these are described, according to the position of the pus :

(a) *Superior* or subphrenic, usually secondary to empyema or other intra-thoracic suppuration in which the kidney is displaced downwards.

(b) *Posterior*, which is the most common and in which the pus lies behind the kidney and in time finds its way to the surface in the loin.

(c) *Inferior*, usually secondary to a retrocæcal appendix, in which the extension of pus occurs downwards to point either in the iliac fossa or, very occasionally, under Poupart's ligament in the thigh.

Bacteriology. In order of frequency the commonest infecting organisms are the staphylococcus, streptococcus, and bacillus coli.

Symptoms and Signs. In the secondary varieties the symptoms and signs of perinephric abscess become superadded to those of the primary disease. For example, during the course of an attack of appendicitis or pyelonephritis a swelling may become evident in the loin which gradually increases in size and is accompanied by signs of septic absorption, such as increased temperature, wasting and sweating. In the renal cases urinary symptoms, such as pyuria, are, of course, present. Or again, an almost painless swelling may appear in one or other loin as a complication of spinal caries, which in some cases is the first symptom of this disease to be noticed by the patient.

In the uncommon primary variety, the onset is usually insidious, but the patient is seriously ill, with signs of septic absorption, and has a high remittent temperature. Pain and tenderness in the loin are marked and muscular rigidity is present.

Whether primary or secondary, a perinephric abscess has the following characteristics : There is a gradually increasing swelling in the loin which extends outwards and backwards. Pain is present and is increased by movements, respiration or coughing. Tenderness and

muscular rigidity on the affected side are marked, and the swelling does not move on respiration, and is ill-defined and fixed on palpation. Œdema of the superficial tissues is often present, and the overlying skin may be reddened.

Diagnosis. This condition must be differentiated from a pyonephrosis, which presents a regular, well-defined swelling extending more forwards than backwards, moving with respiration and not producing œdema or reddening of the overlying skin. The two conditions of pyonephrosis and perinephric abscess may, however, co-exist—the latter being secondary to the former.

Treatment. A perinephric abscess should be opened and drained through the loin as soon as a diagnosis has been made, care being taken to open up all pockets and to explore the areas above and below the kidney. In the secondary varieties an attempt must be made to deal with the cause, such as an appendicitis or empyema, at the same time. Should the kidney be the seat of abscess, pyelonephritis or pyonephrosis, great care is essential, primary nephrectomy being only justifiable if the patient's condition is satisfactory and if the functional capacity of the opposite kidney has been ascertained. As a rule, nephrotomy with drainage of both the pelvis and the perinephric space is all that should be attempted, a secondary nephrectomy, if necessary, being carried out at a later date after complete urological examination.

RENAL ABSCESS

Hæmatogenous infection may occur during the course of an infectious fever, such as scarlet and typhoid, from an infective endocarditis, or from a distant septic focus, such as a boil, carbuncle or whitlow.

Miliary abscesses are formed in one or both kidneys and are either scattered throughout the renal substance, or may coalesce to form a large abscess in one pole (carbuncle of the kidney). Both acute and chronic forms occur.

Symptoms and Signs. Acute Cases. General malaise and rigors are present in addition to the symptoms of an infective disease, and one or both kidneys are enlarged and tender. Albumen, pus, and sometimes blood are found in the urine. In bilateral cases partial suppression occurs and death is inevitable. In unilateral cases recovery may take place.

Chronic Cases. These are usually unilateral, and the symptoms and signs are those of a mild general infection with the addition of enlargement and tenderness of one kidney and the presence of albumen and sometimes pus in the urine.

Symptoms of perinephric abscess or of pyelonephritis may become superadded if the abscess bursts through the renal capsule or into the pelvis.

Treatment. This is non-surgical in bilateral cases with scattered miliary abscesses. In unilateral cases the treatment should at first be expectant, large doses of fluids and alkalis being given, but if the symptoms continue, the kidney should be explored and dealt with according to the condition found. A localised abscess is opened and drained, but if extensive suppuration is present nephrectomy may be necessary provided that the opposite kidney is healthy.

RENAL TUBERCULOSIS

Renal tuberculosis occurs in two forms: (*a*) as part of an acute generalised miliary tuberculosis in which both kidneys are riddled with tubercles; or (*b*) as a tuberculous infiltration of one or other kidney. As the former is of medical interest only, the following account applies solely to the latter.

The disease is said to be primary when the kidney is the first part of the urogenital tract to become infected, and secondary when one of the genital organs is the primary site of the disease. In the primary cases the infection is blood-borne. In the secondary it reaches the kidney by upward lymphatic spread from the genital tract. In all cases some active or healed focus of infection exists in some other part of the body, such as a mediastinal or mesenteric gland.

Renal tuberculosis usually occurs between the ages of 20 and 40 years, is more common in women than in men, and in the right kidney than in the left. In the early stages it is unilateral in over 90 per cent of patients, but, if untreated, it attacks the other kidney in one-third of the cases. Secondary infection may occur by the bacillus coli, streptococcus, and staphylococcus.

Pathological Anatomy. Two forms of renal tuberculosis exist: The first and more common variety begins as a tuberculous pyelonephritis, the disease first attacking the pelvis and calyces with the formation of tuberculous granulation tissue (fig. 1555). Ulceration occurs and spreads

into the renal substance, producing ragged hollowing of the pyramids, and down the ureter with production of tuberculous ureteritis, resulting in thickening of its walls and a shortening in its length, so that its insertion into the bladder is pulled up, as seen by retraction of the ureteric orifice during cystoscopic examination.

The second and less common variety begins as a renal abscess formed by the liquefaction and confluence of several scattered foci

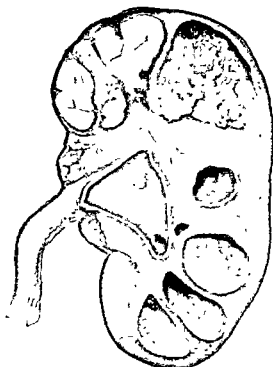


Fig. 1553.—TUBERCULOUS KIDNEY PRACTICALLY NO
RENAL SUBSTANCE LEFT: SEVERAL LARGE CASEATING
MASSES.

(St Paul's Hospital Museum.)

usually near one pole. For a time it has no communication with the renal pelvis, but later it bursts into it, setting up pyelonephritis with discharge of tuberculous material down the ureter, resulting in ureteritis.

In whichever way it begins, some enlargement and lobulation of the kidney follows, due to involvement of other pyramids; and, with inflammatory stenosis of the pelvi-ureteral junction, a tuberculous pyonephrosis may ensue which becomes closed if the obstruction is complete. Although an abscess may occasionally rupture through the renal capsule and form a tuberculous perinephric abscess, as a rule only perinephritis and peri-ureteritis are set up with the formation of adhesions to the surrounding structures.

Secondary cystitis always follows, except in some cases of "closed" renal tuberculosis, and in the male may extend to the genital organs producing prostatitis, vesiculitis, and epididymitis.

Symptoms and Signs. In those cases in which a tuberculous focus exists in the kidney and is not in communication with the pelvis, the only symptoms present are perhaps a feeling of tiredness or weakness and loss of energy. Some slight frequency is present, due to unilateral polyuria, but the urine is normal except for a trace of albumen.

When one or more abscess cavities are in communication with the pelvis and tuberculous material passes down the ureter, the majority of the symptoms are referable to the bladder and consist of increased frequency, *initial and terminal dysuria*, and *changes in the urine*.

There may be some renal aching, but complete destruction of the kidney can occur without this. Pain is a most fallacious symptom as it may occur on the opposite side and be due to compensatory hypertrophy of the other kidney.

Ureteric colic sometimes follows from the passage of tuberculous debris or blood clot. In rare cases hæmaturia may be the first sign of the disease.

There are usually night sweats and a daily rise of temperature of 1 or 1½° F.; any increase over this indicates that secondary infection has occurred, or that some active focus of tuberculosis exists elsewhere in the body.

General malaise, weakness, loss of energy, and some degree of secondary anæmia are, as a rule, present.

Frequency. This occurs at first by day and later at night also. It may be variable, but tends to be progressive, and may eventually become half-hourly or even more frequent. It is at first due to polyuria, then to vesical irritability, and finally to contraction of the bladder from continued cystitis.

Dysuria. The normal desire to micturate becomes more and more exaggerated as the capacity of the bladder decreases. Some burning is complained of during the act, and often intense pain, referred to the tip of the penis or labia majora, on completion. As in other cases of cystitis there may be some terminal hæmaturia.

Changes in the Urine. There is at first polyuria, which exists only on the diseased side and is more marked at night. Later the urine is

pale and acid, and contains a trace of albumen and pus and sometimes tubercle bacilli, but these bacilli are not always found in every specimen examined, and a 24-hour sample should therefore be taken. Often resort must be made to guinea-pig inoculation of the centrifuged deposit before their presence can be confirmed.

A sterile acid pyuria should always be regarded with great suspicion. Hæmaturia may be absent or be present in microscopic amount. It is either terminal and due to cystitis, or intimately mixed with the urine and due to erosion of a vessel in the kidney by tuberculous ulceration. In rare cases it may be profuse and precede other symptoms.

Diagnosis. This is made by a consideration of the history, the symptoms, and a complete urological examination.

Routine examination will determine whether a tuberculous focus exists in the prostate, vesicles or epididymis. In rare cases there may be a tuberculous salpingitis in the female. A thickened ureter can sometimes be felt per rectum or per vaginam; the urine will show the characteristic acid pyuria and tubercle bacilli may be found and perhaps other organisms if secondary infection has supervened.

General examination may reveal a focus of infection elsewhere in the body.

Abdominal examination may show nothing abnormal, or may be unreliable as there is often enlargement and tenderness of a hypertrophied normal kidney while the diseased organ is impalpable and not tender. On deep palpation the ureter can sometimes be felt as a thickened cord.

Cystoscopy. This is characterised by a diminished vesical capacity, and an increased irritability whereby spasm may be induced if the bladder is distended too quickly. The cystoscopic appearances vary with the stage of the disease, and are only typical in the absence of secondary infection. Cystoscopy frequently enables a correct diagnosis to be made even if tubercle bacilli have not been found in the urine, but may be of little help in cases of closed renal tuberculosis, except for noting the absence of one efflux.

In an early case there may be a small cone-shaped area of *hyperæmia*, due to irritation of the mucosa by the abnormal urine, its apex being at one ureteric orifice and its base towards the internal urinary meatus (fig. 1556). The hyperæmia is followed by infiltration and stiffening of the orifice, which becomes *scollen* and fails to show the characteristic elevation and contraction which accompany the gush of urine through

it. The effluxes become increased in frequency, due to the polyuria, and also from the irritating constituents of the urine.

Tubercles soon begin to appear on or near the affected orifice, spreading upwards and inwards towards the fundus, but remaining unilateral for a considerable time (fig. 1557). The apex of the bladder is next affected from direct contact with the base which occurs at the end of micturition, and being of more recent origin may show more typical changes than those that occur near the ureteric orifice. It is, unfortunately, uncommon to see tubercles in a bladder, as they are so frequently obscured by other inflammatory manifestations which are not typical of the disease. If present, however, they consist of small,



Fig. 1556.—CONGESTED RIGHT URETERIC ORIFICE.



Fig. 1557.—RIGHT URETERIC ORIFICE WITH SURROUNDING TUBERCLES.

yellow, raised areas about the size of a pin's head, and are surrounded by a narrow ring of congestion which is sharply demarcated from the normal healthy vesical mucosa (fig. 1557). They usually occur in groups and are closely associated with the blood-vessels.

Sooner or later tuberculous ulcers are formed from rupture and confluence of batches of tubercles (fig. 1558). They resemble tuberculous ulcers on other mucous membranes, being shallow and serpiginous, with undermined irregular margins and a sloughing base. There may be a surrounding ring of unruptured tubercles.

Bullous œdema is usually present in some degree round the ureteric orifice, and may be marked enough to form a polypoid mass which obscures it from view.

The ureteric orifice itself becomes successively hyperæmic, swollen, immobile, and the seat of tubercles. Shortening of the ureter from

tuberculous ureteritis results in increasing retraction of the orifice as compared with its fellow, and distortion of the trigone (fig. 1559). Ulceration of the orifice produces a moth-eaten, irregular appearance of its margins and a gaping meatus. If bullous œdema is marked,

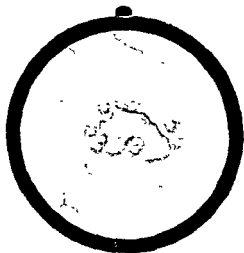


Fig. 1558.—TUBERCULOUS ULCER WITH
SURROUNDING TUBERCLES.

however, these appearances are obscured and the orifice often becomes very difficult to find. With extreme retraction and ulceration, its lips are no longer elevated, and to this condition the term of golf-hole ureter has been applied. Eventually secondary infection occurs, when all the typical tuberculous changes are obscured by the manifestations of generalised cystitis, and inspection alone is insufficient to determine the side of the tuberculous kidney. Occasionally the cystitis is more pronounced on the affected side.

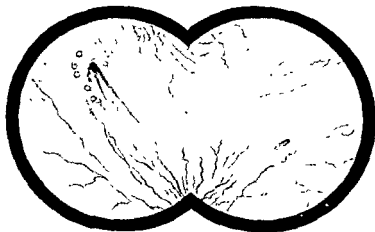


Fig. 1559.—COMPOSITE VIEW OF BLADDER, SHOWING NORMAL LEFT URETERIC ORIFICE AND RETRACTED RIGHT URETERIC ORIFICE, SURROUNDED BY TUBERCLES.

Cystoscopy becomes very difficult owing to the extreme degree of contraction and irritability of the bladder.

Chromo-Cystoscopy. Intravenous injection of 5 cc. of 0.4 per cent indigo-carmin returns from the normal kidney in the usual three to six minutes, but is delayed on the affected side. This test, however, must not be relied upon for the exclusion of disease in the opposite kidney, as in the early stages there is not necessarily a delay in the excretion of the dye.

Ureteric Catheterisation. The ureter on the sound side should always be catheterised to determine the functional capacity of the kidney and to examine its urine. 15 grammes of urea in 100 cc. of water are given 1½ hours previously and an adequate quantity of urine collected. The urea concentration should be over 2 per cent and the specimen free from pus cells and tubercle bacilli. A trace of albumen and a few casts commonly occur, but these do not indicate that the disease has become bilateral. The finding of pus in an acid sterile urine must be viewed with suspicion, and in such cases a guinea-pig inoculation should be carried out. It is unwise to catheterise the ureter on the affected side because of the danger of severe constitutional disturbance and the risk of secondary infection.

Intravenous Pyelography. This is of immense value, not only in the diagnosis of the disease, but also in estimating the stage to which it has progressed and, in most cases, of establishing its unilateral nature.

In the earliest stages the changes may be very slight and confined to one calyx, the apex of which is eroded and appears moth-eaten (see fig. 1539). Later two or three calyces may become affected and give an irregularly dilated shadow. Often no changes are seen in the pelvis or calyces, but the ureter shows irregular dilatation and constriction throughout its course as a result of ulceration. Sometimes an elongated stricture about half an inch in length is seen at its juxta-vesical portion with slight dilatation immediately above it (fig. 1560), this being characteristic of tuberculous disease. The bladder is invariably small and contracted (fig. 1561).

With increasing contraction of the ureter the appearances are those of hydro-ureter and hydronephrosis (fig. 1561), but when destruction of the kidney is advanced the shadow becomes fainter and there is marked delay in the excretion time.

If the obstruction is complete and closed renal tuberculosis is present, there is no excretion at all. The preliminary film may show areas of mottling or definite opacities, if calcification has occurred.

Treatment. Operative. Nephrectomy and ureterectomy are indicated if the disease is unilateral, and in those bilateral cases in which the opposite kidney is only slightly affected, as shown by ureteric catheterisation, pyelography, urea concentration test, and blood urea.

The general condition of the patient must be taken into account, operation being contra-indicated if advanced tuberculosis is present in other parts of the body.

After operation, the patient should be treated by a prolonged period of rest, open air, and nourishing diet, with plenty of milk and fats, and



Fig. 1560.—ASCENDING PYELOGRAM. DILATATION OF LOWER PART OF URETER ABOVE A TUBERCULOUS STRICTURE.



Fig. 1561.—INTRAVENOUS PYELOGRAM. ADVANCED RENAL TUBERCULOSIS ON RIGHT SIDE. EARLY RENAL TUBERCULOSIS ON LEFT SIDE AFFECTING UPPER GROUP OF CALYCES ONLY. NOTE THE DILATED URETERS AND THE CONTRACTED BLADDER.

should if possible be sent to a warm equable climate. A course of tuberculin (T.R.) injections should always be given, beginning with 0.001 cc. and working up to 1 cc., at twice weekly intervals. A reaction should be avoided if possible, but if it occurs the same dose is given a week later and increased more cautiously than before. Alkalis should be the routine, and a sandal-wood oil preparation may help to soothe the inflamed bladder. On no account should the latter be washed out.

The results of operative treatment are usually good, the bladder lesions gradually healing with relief of symptoms, though usually some frequency remains, due to slight permanent contraction.

In bilateral cases the post-operative treatment just described is all that can be carried out.

Nephro-ureterectomy (see page 2872).

RENAL CALCULUS

A stone in the kidney may occasionally be fixed in the renal substance, but it is usually formed in one of the calyces, where it may remain, or from whence it may migrate into the pelvis. If sufficiently small, it may pass into the ureter and either be arrested or travel down the tube into the bladder, where it may gradually increase in size or be passed per urethram during micturition.

Ætiology. Two factors are necessary for the formation of a renal calculus: the precipitation of crystals from the urine, and the presence of a cement substance to bind these crystals together.

Precipitation of Crystals. This results from excess of certain urinary constituents, from changes of reaction in the urine, or from bacterial action. Excess of urinary constituents may be due to errors of metabolism, and is commoner among the poorer classes who often live on a monotonous carbohydrate diet which is lacking in food of animal origin, especially in milk and butter.

Changes in reaction are seen in the stagnating urine of a hydro-nephrosis which predisposes to the formation of stone.

Bacterial action is frequently seen as a secondary manifestation of chronic infection of the lower urinary or genital tracts. Thus both chronic prostatitis and cervicitis must be regarded as predisposing causes of renal calculus.

The Cement Substance. This must be in the nature of an irreversible colloid, such as fibrin, which, when once precipitated, is insoluble. Heredity, sedentary habits, and hard drinking water must also be regarded as contributory factors.

The average age for stone in the kidney is 38 years (Winsbury-White). It is slightly more common in men than women, the two kidneys are affected with equal frequency, and in about 15 per cent of cases bilaterally.

Varieties of Stone. Most calculi are composed of a mixture of different kinds of crystals, the more important varieties being calcium oxalate, uric acid, ammonium and sodium urate, calcium phosphate, ammonium magnesium phosphate, and cystin. The nucleus generally consists of ammonium urate in children, uric acid in adults, and calcium oxalate in late life.

Calcium oxalate stones are the commonest variety, throw a good shadow with X-rays, are extremely hard, and have a concentric laminated structure on section. They vary in colour from white to black according to the amount of staining by blood-pigment. They occur in an acid urine, are usually single, and have a rough surface.

Uric acid stones are single or multiple, and throw no shadow with X-rays unless containing oxalic and phosphatic impurities. They are hard, smooth, often highly polished, and yellowish-brown in colour.

Ammonium and sodium urate stones are commonest in children, have a smooth and sometimes polished surface, are small, soft and friable, and are laminated on section. They are pale fawn in colour, occur in an acid urine, and like uric acid stones throw no shadow with X-rays, except when contaminated.

Calcium phosphate stones are hard, irregular, and greyish-white. They may have a crystalline surface, and occur in neutral or faintly alkaline urine. They throw a fair shadow with X-rays.

Ammonium magnesium phosphate stones (triple phosphate) are composed of dirty white, friable, amorphous masses, and occur in foul alkaline urine where they grow rapidly. They usually have a nucleus of calcium oxalate and, like calcium phosphate, throw a fair shadow with X-rays.

Cystin stones result from incomplete katabolism due to some hereditary defect in oxidation, and contain most of the sulphur of the original protein molecule. They are rare, throw the best X-ray shadows of all, and on section show concentric and radial striation. They are yellow, smooth, and soft, but assume a greenish waxy appearance after removal and are soapy to the touch.

Effects of Stone on the Kidney. A stone, once it has formed in the kidney, steadily increases in size and, unless passed naturally or removed by operation, is bound, in time, to destroy the organ: (1) by acting as a foreign body; (2) by causing obstruction; or (3) by promoting infection.

(1) *Foreign Body.* When present in a calyx, a stone produces a reaction in the surrounding renal tissue causing a localised chronic interstitial nephritis, which results in fibrosis of the secreting substance.

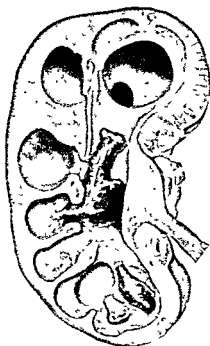


Fig. 1562.—CALCULOUS HYDRONEPHROSIS BRANCHED CALCULUS IN PELVIS AND EXTENDING INTO SEVERAL CALYCES. LOWEST LIMB OF STONE IS FRACTURED AND HAS FALLEN INTO LOWER POLE, WHERE A SMALL SECONDARY CALCULUS IS ALSO SEEN. MARKED DILATATION OF CALYCES WITH THINNING OF PARENCHYMA.

(St. Paul's Hospital Museum.)

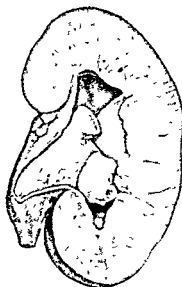


Fig. 1563.—ARTICULATING CALCULI, COMPLETELY FILLING RENAL PELVIS.
(St. Paul's Hospital Museum)

(2) *Obstruction.* This may occur at the mouth of a calyx producing absorption, dilatation and lobulation of that part of the kidney, which gradually becomes converted into a thin-walled sac of fibrous tissue. If multiple calculi are present, these changes may occur simultaneously in other calyces and the whole kidney be replaced by a bag of stones.

Obstruction may also occur if the stone is lying in the pelvis, its degree being inversely proportional to the size of the calculus (fig. 1562).

Thus a small stone may produce intermittent obstruction at the pelvi-ureteral junction and so cause a rapidly enlarging hydronephrosis of the pelvic type, and marked absorption of the renal substance. A large stone may be present for months without producing any characteristic symptoms and in time assume the shape of a complete cast of the kidney without causing any dilatation (fig. 1563).

(3) *Infection.* In most cases careful examination of the urine will show evidence of infection, such as microscopic quantities of pus, which indicates a gradually progressing mild pyelonephritis. An acute attack may occur at any time with multiple foci of infection of the renal tissues and lead to suppression of urine on that side.

Calculous pyonephrosis may result from infection of a calculous hydronephrosis, or follow an acute pyelonephritis complicating a stone (see fig. 1553).

Some degree of perinephritis is always present, and occasionally a perinephric abscess may form from leakage of the pyonephrosis or rupture of a renal abscess.

Symptoms and Signs. These vary from agonising renal colic due to the attempts of a small pelvic stone to pass down the ureter to a complete absence of symptoms, or at most some lumbar aching due to the presence of a large fixed calculus.

The cardinal symptoms are pain and hæmaturia and, in the absence of gross infection, are present by day only and are often brought on or increased by exercise or jolting.

Pain. This is of two kinds : (i) fixed renal pain and (ii) renal colic. The two may co-exist.

(1) *Fixed renal pain.* This consists of severe aching pain in the loin, of varying intensity, most marked behind at the junction of the last rib and erector spinæ muscle, and passing forwards just below the costal margin. It is increased by movement, relieved by rest, and is due to distension of the renal pelvis with urine from blocking of the pelvi-ureteral junction by the stone.

(2) *Renal colic.* This is caused by a small movable stone in the pelvis which has engaged with and is being forced down the ureter by violent peristaltic contractions of its walls. It begins over the kidney and radiates along the line of the ureter into the groin, to the testicle in the male, and to the labium majus in the female. The testis is

retracted by the cremaster muscle, and may be exquisitely tender, and remain so for some time. An attack is often brought on suddenly by some unusual form of exercise. If severe, the patient rolls about in absolute agony with knees drawn up; the face is pale, there is profuse sweating, vomiting occurs, and signs of severe shock with muscular rigidity are present. Small quantities of urine are frequently and painfully voided, followed at a later stage by the passage of a large quantity of urine of low specific gravity. The attack may last from a few minutes to some hours, acute exacerbations alternating with severe renal aching, and ending suddenly by the slipping back of the stone into the pelvis of the kidney.

Hæmaturia. This is present in about half the cases, and varies greatly in amount. It may follow an attack of renal colic or be brought on by exercise or jolting.

Infection. This is usually present in mild degree, and may be symptomless, or produce such conditions as cystitis, pyelonephritis, pyonephrosis, perinephritis, and perinephric abscess with their resulting symptoms and signs, such as frequency, dysuria and pyuria, which may be marked at night, when rest will no longer give the patient relief.

In calculous pyonephrosis the pyuria is abundant and intermittent, attacks of lumbar pain and fever coinciding with a temporary clearing of the urine from blocking of the pelvi-ureteral junction, and being followed by a diminution of pain and profuse pyuria.

In the absence of gross infection, the urine is usually acid and may contain hyaline casts and crystals of calcium oxalate, uric acid or phosphates.

Diagnosis. This is made by the history, a consideration of the symptoms and a complete urological examination. The previous passage of a stone is, of course, an important point. In the great majority of cases routine examination reveals some chronic inflammation of the genital tract, such as prostatitis or cervicitis.

Abdominal examination may elicit tenderness of one or other kidney, and sometimes overlying muscular rigidity, especially if infection is present, and occasionally a hydro- or pyo-nephrosis can be felt. In rare cases a hard irregular grating mass can be palpated in the loin.

The urine may be free from gross infection and contain only a few

pus cells, or be cloudy and full of pus, organisms, and sometimes crystals of various kinds. Occasionally pyuria may be the only symptom.

Cystoscopy may show cystitis or a cloudy efflux from one orifice, the lips of which are injected. Occasionally blood may be seen to emerge, especially if the suspected kidney be firmly palpated. Intravenous indigo-carminc may be delayed on the affected side, and the efflux diminished in force and quantity.



Fig. 1564.—ASCENDING PYELOGRAM SHOWING STONE IN PELVIS OF LEFT KIDNEY. THE PRELIMINARY FILMS OF THIS CASE ARE SHOWN IN FIG. 1526.

made and the urea concentration to be estimated, following the administration of 15 grammes of urea in 100 cc. of water $1\frac{1}{2}$ hours previously.

Differential Diagnosis. Only about 50 per cent of cases of renal colic are due to stone, the remainder being caused chiefly by chronic renal infection. A few cases are due to such conditions as a movable kidney,

Pyelography, by the intravenous or ascending route, is the most important investigation, the preliminary film showing one or more shadows in the renal region (see fig. 1526) which maintain their relationship to the kidney during respiration. Subsequent films demonstrate that these shadows are renal stones and not calcified glands, and also the exact position they occupy in the kidney (fig. 1564). It must be remembered that a pure uric acid calculus will throw no shadow with a plain X-ray. Sometimes, however, its presence can be demonstrated in a pyelogram because, by displacing the dye substance, an area of diminished density or "negative" shadow is seen. The pyelogram further assesses the amount of damage done to the kidney, and gives exact information as to the presence and the functional capacity of the organ on the opposite side.

Ureteric catheterisation and the collection of renal specimens will enable a separate bacteriological examination to be

the passage of blood clot or debris or of oxalate or uric acid crystals. Renal colic may be simulated by hepatic colic, tabes or hysteria.

Treatment. This must be considered under three headings, viz.: The treatment of (1) certain symptoms of stone; (2) the stone itself; and (3) the cause of the stone.

(1) *The Treatment of Certain Symptoms of Stone.*

- (a) *Renal Colic.* If severe, morphia $\frac{1}{2}$ gr. and atropine $\frac{1}{100}$ gr. should be injected as soon as the diagnosis has been made. Morphia $\frac{1}{4}$ gr. may be repeated 4-hourly if necessary. Occasionally the attack is so acute that drugs fail to give relief, when the patient should at once be cystoscoped and an attempt made to pass a ureteric catheter to the kidney. If the catheter can be made to pass the stone, urine will be drawn off under great tension and all acute pain cease as soon as the pelvis is empty. A large antiphlogistine dressing will do much to relieve the post-renal aching which invariably follows the attack.
- (b) *Renal Hæmaturia.* This is usually small in amount and rarely calls for special treatment. Occasionally profuse bleeding may follow a fall or a blow, when the patient must be put to bed, an ice-bag applied to the loin, and 20 cc. of coagulen-ciba injected into the buttock.
- (c) *Suppression of Urine.* This is dealt with under "Calculous Anuria" (see page 2806).

(2) *The Treatment of the Stone Itself.*

This may be medical, instrumental, or operative, and it will be convenient to describe the various methods which are commonly used and the indications for each.

Medical. This is employed in conjunction with instrumental or operative measures, but may constitute the sole method of treatment in certain extensive bilateral cases of calculous disease with destruction of renal tissue on both sides, especially if the stones are large and fixed and not giving rise to marked symptoms. Also in cases in which numerous small calculi are continually being passed and in which X-rays show that no large stone or group of smaller ones is present.

Medical treatment consists of the promotion of diuresis and the administration of urinary disinfectants in order to minimise infection;

the elimination of certain foodstuffs which are known to encourage the formation of crystals, or which increase the work of an already damaged kidney ; and the general care of the patient's health, and especially of the bowels. Diuresis can be secured by alkalis, by increasing the fluid intake (avoiding chalky water), and the administration of certain waters, such as Contrexéville and Vittel. Urinary disinfectants include hexamine in an acid urine, caprokol, and pyridium.

Oxaluria may be caused by strawberries, raspberries, and other berries, spinach, tomatoes, asparagus and rhubarb ; uric acid crystals by kidney, liver, sweetbreads and brains ; and phosphaturia by excessive alkalinity of the urine and by worry and mental strain.

Protein food in general may throw too great a strain on the kidneys and should be restricted, but milk and butter can be given freely. The general health is maintained by tonics, graduated exercises, adequate rest, suitable climate, and by regulation of the bowels. An effervescing dose of magnesium citrate is advised daily before breakfast.

Instrumental. This is fully described under "Ureteric Calculus," and is only applicable to stones which are small enough to pass naturally. It consists of ureteric dilatation with bougies and Buerger's olives and the injection into the renal pelvis through a ureteric catheter of olive oil and papaverine. Instrumentation is especially indicated if some degree of ureteric stricture is present which might obstruct a stone in its downward passage. It is also indicated in the form of ureteric catheterisation and pelvic lavage in order to reduce both pre- and post-operative renal infection, and may be a useful adjunct to medical treatment in inoperable bilateral cases.

Operative. This should always be carried out unless either the efficiency of both kidneys has become seriously damaged by extensive bilateral calculi, or the stone is small enough to pass naturally, in which case an attempt should first be made to assist its passage by medical and instrumental means.

Before a patient is operated upon, certain definite facts must be established by pre-operative investigations, the results of which will determine the type of operation to be performed.

(a) *In Unilateral Cases.*

- (1) The functional capacity of the opposite kidney is good.
- (2) The affected kidney is so damaged by back pressure or infection that it is not worth saving, e.g. calculous pyonephrosis.

(3) The stone is so large that its removal would damage the kidney to the extent of rendering it worthless.

(4) The stone can be removed, but is likely to recur.

Nephrectomy is indicated in conditions (2), (3) and (4) (see page 2830).

(5) A moderate-sized stone is lying free in the pelvis.

(6) A few small calculi are present in a calyx.

Pyelolithotomy, which consists of removing the stone or stones through an incision in the posterior wall of the renal pelvis, is indicated in (5) and (6) (see page 2837).

(7) A large branched calculus is present, the kidney is only moderately affected, and there is every hope of a good functioning organ after removal of the stone.

(8) A stone or collection of stones lies in a dilated calyx.

Nephrolithotomy, which consists of cutting through the renal cortex until the stone is reached, is indicated in (7) and (8) (see page 2840).

Occasionally a combined operation of nephro- and pyelolithotomy will have to be performed when one stone is lying in the pelvis and another in a dilated calyx.

Partial nephrectomy is sometimes carried out if a stone is lying in an infected dilated calyx which has become partly or completely shut off from the pelvis. A wedge-shaped incision is made, with excision of the affected calyx including the stone.

(b) *In Bilateral Cases.*

Here the functional capacity of each kidney must be determined, the size, shape and position of the stone or stones, the degree of infection if present, and the presence or absence of complications.

From these investigations the following facts can be deduced :

(1) That a good functional result can be expected after extraction of the stone, either by pyelolithotomy or by nephrolithotomy.

(2) That one kidney is more damaged than the other.

In (1) and (2) the stone is removed from the better kidney first, and from the other six months later.

- (3) That a good functional result can be expected after removal of the stone from one side, but not from the other.

In (3) the good kidney is operated on first and, after an interval, its functional capacity again estimated. If sufficient to carry out the entire excretory function of the body, nephrectomy is performed on the other side.

- (4) That both kidneys are so damaged that operative interference with either organ would cause irreparable harm.

In (4) palliative measures by medical and instrumental means are the only forms of treatment possible.

(3) *The Treatment of the Cause of the Stone.*

In the majority of cases careful investigation will reveal some factor which is directly or indirectly responsible for the presence of a calculus, and unless such a factor is removed or treated, a recurrence of the stone in the affected kidney is likely to take place.

Such factors include :

- (a) Chronic genital infection, e.g. prostatitis and cervicitis.
- (b) Chronic lower urinary tract infection, e.g. chronic urethritis and cystitis.
- (c) Chronic lower urinary tract obstruction, e.g. stricture and prostatic obstruction.
- (d) Chronic upper urinary tract infection, e.g. pyelonephritis and pyonephrosis.
- (e) Chronic upper urinary tract obstruction, e.g. ureterocele, ureteric stricture, stenosis of the pelvi-ureteral junction, and hydronephrosis.

The treatment for each of these is described under its individual heading.

CALCULOUS ANURIA

Calculus anuria is a term applied to complete suppression of urine which is directly or indirectly due to a calculus. It occurs mainly in men between 40 and 60 years of age, in whom one kidney is out of action due either to congenital absence or atrophy, or to operative removal, extensive calculous disease, interstitial nephritis, or hydro- or

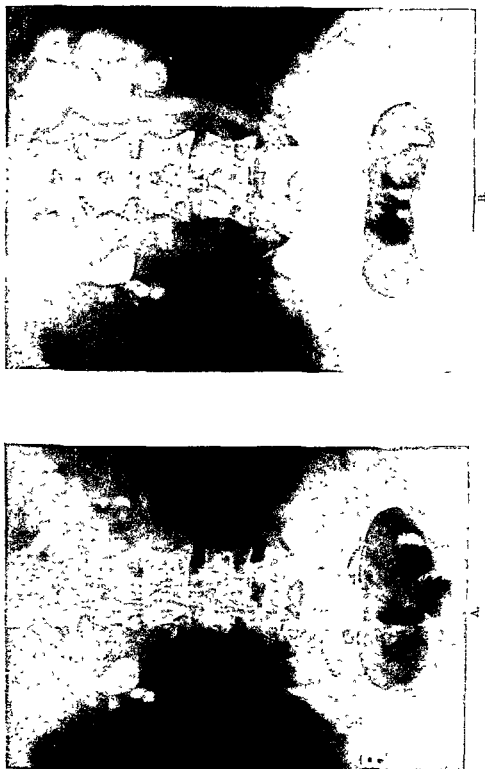


FIG. 1565.—CALCULOUS ANURIA. A. PLAIN X-RAY. B. INTRAVENOUS PYELOGRAM. THE PLAIN X-RAY SHOWS A BRANCHED CALCULUS COMPLETELY FILLING THE RIGHT KIDNEY, SEVERAL SMALL STONES IN THE LEFT RENAL REGION AND ONE STONE IN THE REGION OF THE LOWER END OF THE LEFT URETER. THE PYELOGRAM SHOWS THAT THE RIGHT KIDNEY IS PRACTICALLY FUNCTIONLESS, THAT THE SHADOWS ON THE LEFT SIDE ARE STONES IN THE LOWER GROUP OF CALYCES OF THE LEFT KIDNEY AND THAT THE LOWER END OF THE LEFT URETER CONTAINS A STONE.

pyo-nephrosis. The opposite kidney, which has been carrying out the entire excretory function, is suddenly blocked by the migration of a stone from its pelvis into the ureter (fig. 1565), or by an attack of pyelonephritis which becomes superimposed on a stone or stones in its pelvis or calyces.

Symptoms and Signs. These usually occur in three stages: Stage of onset, stage of tolerance, and stage of uræmia.

Stage of Onset. When due to the impaction of a stone in the ureter, the onset is sudden and is accompanied by renal colic and sometimes by slight hæmaturia. Anuria is complete and catheterisation proves that the bladder is empty.

When due to pyelonephritis superimposed on stone, the onset is less sudden, may be comparatively painless, and complete anuria is not established for two or three days.

Stage of Tolerance. Very little discomfort is complained of during this stage, which may last from five to eight days. The anuria may be complete, but frequently a little urine is secreted and occasionally an attack of polyuria may occur. There is always much anxiety due to the absence of micturition, and towards the end of this stage there is lassitude, headache, sleeplessness, nausea, constipation and flatulence.

Stage of Uræmia. This lasts for about two or three days and is characterised by progressive drowsiness. Coma, hallucinations, muttering and delirium may occur. The pulse and respiration become slow and irregular and Cheyne-Stokes breathing is common. The temperature is sub-normal and the bowels are constipated; hiccough and vomiting are frequently present, and death occurs from heart failure due to pulmonary cedema or during an attack of dyspnoea.

Diagnosis. This is made by the history, a consideration of the symptoms, usually of renal colic, and by a complete urological examination. Catheterisation proves that the bladder is empty and that therefore suppression has occurred; cystoscopy shows that there is no vesical cause for the suppression.

X-rays may reveal a shadow in the line of the ureter, and if this is the side on which the attack of colic is present or has recently occurred, the diagnosis of obstruction of the only functioning kidney is confirmed.

Treatment. An attempt should at once be made to pass a catheter through a single catheterising cystoscope to the affected kidney, though difficulty may be experienced in negotiating the obstructing calculus. If successful, urine will flow from the catheter under pressure, the acute symptoms of renal colic subside, and the patient's general condition improve. The catheter should be allowed to remain in position for several days, during which time an exact estimate is made of the state of affairs by pyelography, and a definite plan of operation decided upon.

If the obstruction cannot be negotiated, the kidney should at once be exposed and drained. If the offending calculus can be palpated, it should be removed at the same time, but in other cases it is dealt with at a later date, when the patient has recovered from the anuria, and after an exact diagnosis of the position of the stone has been made. Every effort should be made to re-establish urinary secretion after ureteric catheterisation or nephrotomy, by fluids, alkalis, and intravenous salines. The injection of 1 to 2 cc. of salyrgan into a vein is of great value. A purge should be administered and sweating promoted by hot packs or radiant heat baths.

The condition is always extremely serious, and the prognosis depends entirely on the stage at which the patient is seen.

CYSTS OF THE KIDNEY

The commonest variety is congenital cystic disease, but a solitary cyst may be encountered. *Small multiple cysts may occur in chronic nephritis; dermoid and hydatid cysts have been described.*

Congenital Cystic Disease (Polycystic kidney) (fig. 1566). This condition is usually met with either during infancy or in adult life between the ages of 25 and 45 years, and is more common in women. Both kidneys are affected, but usually one more than the other. It is of congenital origin, may occur in more than one member of the same family, and is due to failure of fusion of the primitive metanephric duct (from which are formed the ureter, renal pelvis, and collecting tubules) with the secreting tubules. The result is a multiple collection of cysts, varying in size from a pin's head to a golf ball, which are scattered uniformly throughout the kidney, causing the latter to become enormously enlarged and to assume the appearance of a cluster of grapes.

There may be other associated abnormalities, such as pin-hole

meatus or hydronephrosis, and the disease is said to be more common in misplaced or maldeveloped kidneys.

The cysts are translucent, ranging in colour from light yellow to dark brown, according to whether they contain a clear fluid or thick blood-stained material, and are separated by a variable amount of kidney substance in which interstitial fibrosis has occurred. They are lined by columnar, cubical, or flattened epithelium, according to their size, and the fluid contains traces of urea, albumen, chlorides, phosphates and cholesterin. Epithelial cells, casts, red and white blood-

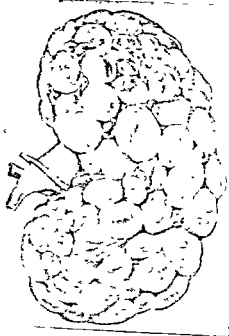


Fig. 1566.—POLYCYSTIC KIDNEY.

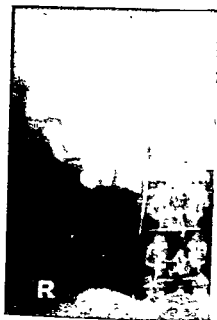


Fig. 1567.—PYELOGRAM OF A POLYCYSTIC KIDNEY.

corpuscles, and occasionally crystals of calcium oxalate and uric acid may be present. A similar change may occur in the liver and pancreas, while other organs also are not exempt.

Symptoms and Signs. In *infants* one or both kidneys may be so large as to cause obstruction during birth, or the condition may not be noticed until after the child is a year old. Death usually occurs from uræmia before the end of the third year. The bilateral nature of the disease will help to exclude sarcoma which is unilateral.

In *adults* there may be no symptoms for years, but eventually a hard painless renal tumour is felt, which retains the shape of a kidney, moves on respiration, is rarely tender, and has a nodular surface.

Later there may be some dull aching in the loin, and occasional attacks of renal colic followed by hæmaturia. Perinephritis, with pain and rigidity in the loin, and fever may follow the rupture of one or more of the cysts. At a later stage a similar smaller tumour may be felt on the opposite side.

The urine is increased in amount and is pale, of low specific gravity, usually contains albumen, and possibly blood. The renal function gradually becomes diminished from the associated chronic interstitial nephritis, until, in the last stages, oliguria and chronic uræmia occur with characteristic symptoms, which may be followed by anuria.

Diagnosis. This is made by a consideration of the symptoms and signs and by a urological investigation.

The genital and lower urinary tracts are normal. The urine may show the characteristic chemical and bacteriological changes, and chromo-cystoscopy a delay in the excretion of indigo-carmin, usually more marked on one side than the other.

Intravenous pyelography shows concave shadows on the pyelogram, due to encroachment of the cysts on the pelvic cavity. At a later stage the latter becomes almost completely obliterated and the pyelographic shadow much reduced in size, being represented by narrow erratic streaks with concave margins. Some of these are enormously increased in length, due to displacement outwards of some of the calyces by the cysts, and appear as irregular, straggling shadows extending far beyond the usual limit of the pelvis (fig. 1567). The calyces themselves as a rule show varying degrees of secondary dilatation due to obstruction.

In some ways the pyelogram may suggest a growth, but the bilateral appearances should help to exclude this. If in doubt, confirmation should be obtained by ascending pyelography.

Treatment. This is medical, and is the same as for chronic interstitial nephritis. Surgical treatment, such as nephrectomy, is out of the question, owing to the bilateral nature of the disease. The only justifiable procedure is Rovsing's operation, which consists of exposing the kidney and incising as many of the cysts as possible, and draining the wound.

Solitary Cyst (fig. 1568). This is generally considered to be a retention cyst, is very rare, and is unilateral. The cyst may be larger

than the kidney itself and rarely produces symptoms until it has attained a large size. It is composed of a thin translucent fibrous tissue wall, enclosing a clear amber fluid containing albumen, phosphates, chlorides, and traces of urea. There is no communication with the pelvis of the kidney, which is usually normal though it has been known to contain a calculus.

Symptoms and Signs. There may be some dull aching in the loin, and bowel symptoms are common. A renal tumour may be felt which moves on respiration.

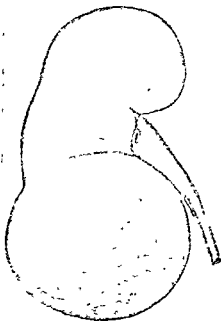


Fig. 1568.—SOLITARY CYST OF KIDNEY.
POSTERIOR VIEW.
(Operation specimen, Author's case)



Fig. 1569.—PYELOGRAM SHOWING SOLITARY CYST OF
LEFT KIDNEY. A URIC ACID CALCULUS WAS PRESENT
IN THE RENAL PELVIS.

Diagnosis. The genital and lower urinary tracts are normal. Intravenous pyelography will show that the renal pelvis and most of the kidney outline are normal. A faint globular shadow which maintains a constant relationship to the kidney during respiration (fig. 1569) is attached usually to the lower pole.

Treatment. This consists of exposing the kidney, cutting away as much of the cyst wall as possible, and cauterising the remainder, which is still attached to the organ, with pure carbolic acid. Occasionally partial or complete nephrectomy is necessary.

NEW GROWTHS OF THE KIDNEY

Innocent. Innocent renal growths are extremely rare ; they include adenomata, lipomata, fibromata and papillomata of the pelvis. Small tumours do not give rise to any symptoms and are therefore only found post mortem. If of sufficient size to be detected clinically, they must *always* be regarded as malignant and treated as such.

Malignant. Malignant renal growths may attack either the parenchyma or the pelvis. The majority occur either in infants under the age of 4 years, when they must be regarded as congenital, or in adults over 40. They are more common in men than in women, and on the right side than the left.

Growths of the Renal Parenchyma.

- (a) Hypernephroma.
- (b) Carcinoma and sarcoma.
- (c) Embryoma.

(a) *Hypernephroma* (fig. 1570). This constitutes over three-fourths of malignant renal tumours, and is seen in adults, usually over the age of 40 years. It derives its name from a resemblance on microscopic section to the zona fasciculata of the cortex of the suprarenal gland. At one time it was thought that it originated in small suprarenal rests which may be found immediately below the renal cortex, but this theory is no longer accepted for three reasons : (i) Hypernephroma of the suprarenal gland does not occur ; (ii) suprarenal rests are commoner in the lower pole of the kidney, while hypernephroma is usually found in the upper pole ; and (iii) suprarenal rests occur in other parts of the body, but never give rise to a hypernephroma.

It is difficult to place this growth in any of the ordinary groups, but it is reasonable to suppose that it is a kind of carcinoma of the renal tubules, possibly arising from remains of the Wolffian body. It consists of a delicate stroma made up of a fine capillary network in intimate contact with the cells forming the growth. These cells are large, swollen, and clear, and contain a rounded nucleus, which is displaced to one side owing to degenerative changes in the protoplasm. Macroscopically, in the early stages, a definite capsule surrounds the tumour, which is broken up by coarse semi-translucent fibrous bands into a

number of loculi which contain a characteristic yellowish-red substance. This colour is due partly to the presence of a large quantity of fat in the cells and partly to patches of necrosis and hæmorrhage.

A hypernephroma is unilateral and arises immediately beneath the capsule of the kidney, most commonly at its upper pole. The right side is more frequently affected than the left, and it is more common in males than in females. It is relatively the most innocent of the renal growths, and if nephrectomy is carried out before invasion of the kidney has occurred through the capsule, the prognosis is fairly good.

Following renal involvement, rapid growth takes place directly into the lumen of the renal vein and pelvis, and metastases soon occur in the liver, lungs, bones and skin. The lymphatics are not, as a rule, involved. Other diseases of the kidney, such as calculus and tuberculosis, have been found to co-exist, but cannot be regarded as ætiological factors.

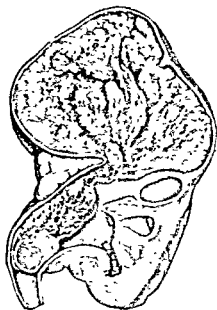


Fig. 1570.—HYPERNEPHROMA OF KIDNEY.
(Operation specimen, St. Paul's Hospital
Museum.)

Symptoms and Signs. The cardinal symptom consists of profuse, painless, periodic bleeding, followed some months later by the appearance of a tumour in the loin, which has the characteristics of a renal swelling. Hæmaturia is present in over 90 per cent of the cases, and is the first symptom in 70 per cent. The blood is intimately mixed with the urine, and varies in quantity from time to time. Long slender ureteric clots are sometimes found and may be preceded by a burst of ureteric colic. In rare cases retention occurs from clotting of blood in the bladder. Renal aching occasionally results from obstruction of the renal pelvis due to blocking of the pelvi-ureteral junction. In a few cases there is slight fever at night, which may arouse an erroneous suspicion of pyonephrosis. A tumour in the loin is present in all late cases, and occasionally precedes the hæmaturia. On the left side a spontaneous varicocele may occur from blocking of the left renal vein by growth, and consequent occlusion of the left spermatic vein which opens into it. Cachexia and wasting are late symptoms. In untreated cases death usually occurs in three or four years after the first symptom.

Diagnosis. Painless hæmaturia is a symptom which, if due to hypernephroma, is of the gravest import and should lead, without exception, to an immediate urological investigation. Only too often is this omitted, either because this sign is ignored by the patient, or because his doctor is not fully aware of its significance. It is only by early diagnosis and operation that a cure can be obtained. Routine examination usually shows the genital and lower urinary tracts to be normal, except for the possible presence of blood in the urine. Albumen, if present, is due to toxic nephritis. Although pus, organisms, and other abnormal constituents in the urine are, as a rule, absent, in rare cases portions of growth may be found. In a few cases, a varicocele of recent origin may be observed on the left side.

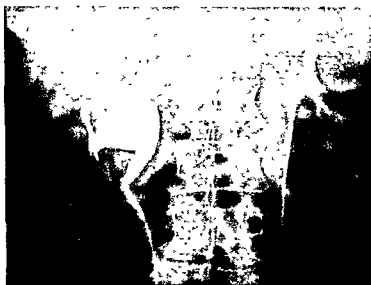


Fig. 1571.—DOUBLE ASCENDING PYELOGRAM, SHOWING A FILLING DEFECT ON THE RIGHT SIDE DUE TO THE INTRA-PELVIC PROJECTION OF A GROWTH.

Cystoscopy excludes a bleeding point in the bladder and may show a blood-stained efflux on one side. If hæmaturia is not actually present, firm pressure on one or other loin will often produce it.

In at least 70 per cent of cases intravenous pyelography will demonstrate some deformity or even absence of shadow on the affected side, and prove the presence of a normal kidney on the other. In all cases, however, an ascending pyelogram must be carried out, when positive evidence will be obtained in over 90 per cent of cases (fig. 1571). These findings are extremely variable owing to five distinct changes which may be produced in the pyelographic shadow by a renal tumour, and an irregular combination of these often leads to much confusion in the interpretation of the pyelograms, even when viewed by an

expert: (1) When a growth is of such a size as to involve the pelvis, its first effect is to obliterate one or more of the calyces and eventually to bulge into the pelvis, producing a definite filling-defect. A few calyces, or a portion of a pelvic shadow, may therefore be absent from the pyelogram. (2) Enlargement of the kidney by the growth may cause elongation or retraction of the other calyces in the organ. Their width becomes much diminished and they tend to taper towards their extremities, giving to the pyelogram a thin, curved, streaky appearance, known as a spider deformity. (3) Total obliteration of the junction of the pelvis and calyces may occur, and the pyelogram be represented merely by a series of irregular and widely separated blotches. (4) Dilatation of a group of calyces may occur from ulceration of the growth into the pelvis, and in rare cases the latter may be dilated from obstruction at the pelvi-ureteral junction. (5) There may be a complete absence of excretion on the affected side, although ascending pyelography may show a varying degree of hydronephrosis affecting both the pelvis and the calyces alike. This is due to an absence of secretion caused by pressure of the growth on the renal vessels, and an atonic dilatation of the pelvis and calyces.

There is some resemblance in the pyelographic shadow of a renal growth to a polycystic kidney, but the main distinctions between the two are that in polycystic kidney (i) the majority of the calyces are elongated, they seldom taper, and are irregularly widened and displaced; (ii) the pelvis may be diminished in size by compression but is never invaded; (iii) the calyces often appear crescentic; and (iv) the condition is bilateral.

(b) *Carcinoma and Sarcoma.* Both carcinoma and sarcoma of the renal parenchyma are rare tumours, but sometimes occur in adults over the age of 40 years. They are more malignant than a hypernephroma. Microscopically a carcinoma resembles tubular renal epithelium, and consists of alveoli surrounded by definite fibrous septa containing columns of cells. Macroscopically the growth is of a whitish-brown colour and infiltrates the whole kidney and pelvis, there being no formation of a capsule.

A sarcoma arises, either immediately below the renal capsule or from the fibrous tissue of the renal hilum. Macroscopically it resembles a carcinoma, although the kidney substance is, as a rule, less involved.

Symptoms and Signs. These are similar to those of hypernephroma, but are much more marked. Hæmaturia is early and persistent, and

often occurs before the tumour can be palpated in the loin. The patient is cachectic, wastes rapidly, and is usually dead within a year of the onset of symptoms.

Diagnosis and Treatment. Early investigation is essential, and there should be no delay in carrying out nephrectomy if cystoscopy shows a unilateral hæmaturia, and pyelography a filling-defect on that side and a normal kidney on the other. Even with early diagnosis and treatment the prognosis is extremely grave.

(c) *Embryoma.* Embryonic tumours occur in infants between the ages of one and three years and may occasionally be bilateral. They can arise from the capsule, from the peri-vascular connective tissue, or from the substance of the kidney, and on section have a greyish brain-like appearance showing in parts an alveolar arrangement of the cells and usually an ill-defined capsule.

An embryonic tumour may be a pure round- or a spindle-celled sarcoma, but usually contains bundles of undeveloped striped muscle and some tubules lined with epithelium. Growth is exceedingly rapid and the mass may eventually fill most of the abdominal cavity. Though highly malignant, an embryoma rarely gives rise to metastases, but causes death from exhaustion within six months.

Symptoms and Signs. A tumour in the loin is, in the majority of cases, the first symptom, and for a time causes no marked inconvenience. Later, hæmaturia may occur and the child begin to waste rapidly. Steadily increasing distension of the abdomen is observed on the affected side and a firm nodular tumour can be felt. Large anastomosing veins running immediately beneath the overlying skin are often seen.

Growths of the Renal Pelvis (fig. 1572). Primary growths of the renal pelvis are uncommon, the most frequent being papilloma and papillary carcinoma, although sarcoma, myxoma, rhabdo-myoma and lipoma have been described. Owing to the impossibility of distinguishing a papilloma from a carcinoma by any known method of investigation, and owing to the tendency of the former to become carcinomatous, all growths of the renal pelvis must be regarded as malignant.

The growth spreads by direct continuity into the pyramids, causing slight enlargement of the kidney, and travels down the ureter, eventually protruding through the ureteric orifice into the bladder (fig. 1573).

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The growth spreads by direct continuity into the pyramids, causing slight enlargement of the kidney, and travels down the ureter, eventually protruding through the ureteric orifice into the bladder (fig. 1573).

The downward spread must be remembered when this protrusion is seen on cystoscopy, as a cure can only be obtained by complete removal of the kidney and ureter with the contained growth. Obstruction of the pelvi-ureteral junction by fragments of growth may produce an intermittent hydronephrosis, with consequent attacks of renal colic, severe lumbar aching and rapid enlargement of the kidney. In the later stages the lumbar glands become invaded by lymphatic spread.

Symptoms and Signs. The two cardinal symptoms are hæmaturia and pain. The bleeding is usually intense and may continue for months at a time without intermission.

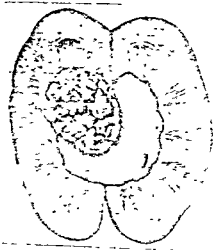


Fig 1572.—PAPILLARY CARCINOMA OF RENAL PELVIS.
(Operation specimen, St. Paul's Hospital Museum.)



Fig 1573.—GROWTH PROJECTING FROM RIGHT URETERIC ORIFICE.

The pain consists of severe lumbar aching from distension of the renal pelvis due to obstruction, or of renal colic from the passage of blood clot and portions of growth down the ureter. The size of the kidney is variable and depends on the degree of associated hydronephrosis.

Untreated cases may live for years, but eventually there is a rapid progress of the disease and death from exhaustion.

Diagnosis. As in growths of the renal parenchyma, routine examination of the genital and lower urinary tracts shows no abnormality, with the exception of the urine, which contains blood and sometimes fragments of growth. On abdominal examination a tumour may be felt

in the loin, but this sign is inconstant, depending on the degree of associated hydronephrosis, and its absence should in no way influence the diagnosis.

Cystoscopy may show unilateral hæmaturia and sometimes what appears to be a papilloma projecting from the ureteric orifice.

Intravenous pyelography may vary greatly on the affected side, but will prove that the other kidney is normal. A small growth of the pelvis may not show a filling-defect at all, in which case an ascending pyelogram should be carried out. Large growths may partly fill or completely obliterate the pelvic shadow. An apparently normal pyelogram may contain a relatively clear area which shows mottling due to penetration of the opaque medium amongst the villi of the growth. A filling-defect may also be caused by the presence of blood clot. If a hydronephrosis is present, the characteristic appearances will be shown.

Treatment of Renal Growths. This consists of immediate nephrectomy in all cases in which investigation has shown that the condition is still operable, and that the opposite kidney is sound.

In growths of the renal pelvis the entire ureter, and, if necessary, a portion of the bladder surrounding the ureteric orifice, should be removed at the same time. The prognosis depends entirely on the stage at which the diagnosis is made and on the performance of a radical operation, which must include the removal of the perinephric sheath with its contained fat. If the tumour is large the peritoneal cavity should be opened, the peritoneal aspect of the tumour examined, and a search made for secondary deposits in the liver and lumbar lymph glands.

OPERATIONS ON THE KIDNEY

Preliminary Investigation of the Patient. The diagnosis of a disease affecting the kidney must always be fully established, and its exact nature and extent determined by modern methods of routine and special urological examination. The amount of damage which has been caused to the organ is estimated by the renal function tests. The presence of a healthy functioning kidney on the opposite side must be ensured before nephrectomy is undertaken. The methods of investigation have already been fully described in Chapter I and under the various diseases of the kidney.

Preliminary Preparation of the Patient. (a) *Bowels.* It is of the utmost importance to ensure a regular action of the bowels for at least a fortnight before operation, and any tendency to constipation must be controlled by the regular use of an aperient such as cascara evacuant. One to three vegetable laxative pills, according to the degree of constipation present, should be given two nights before operation, but no aperient on the night before. The bowel should be emptied by an enema on the morning of the operation.

During the preliminary preparation the diet should be light and nutritious and starchy foods avoided, glucose barley sugar being included for the last three days.

(b) *Renal Function.* Every attempt should be made to improve the renal function if this has been lowered by the disease affecting the kidney. As a rule this can be brought about most effectively by drinking large quantities of water and by the administration of diuretic waters, such as Contrexéville or Vittel.

(c) *Urinary Infection.* Urinary infection, if present, should be treated by the administration of hexamine 10 grs. before meals and an acid mixture, such as the following, after meals:

R/	
Acid phos. dil.	} aa 8 m.
Acid nit. hyd. dil.	
Liquor strychninæ	3 m.
Spt. chlorof.	10 m.
Infus. gent. co.	ad ½ oz.
Sig. ½ oz. ex. aq. t.d.s. p.c.	

(d) *Operation Area.* The skin is shaved and painted with 3 per cent picric acid in spirit the night before operation.

Anæsthesia. The best anæsthetic consists of gas, oxygen and ether, preceded by the injection of $\frac{1}{16}$ grain of atropine hypodermically three-quarters of an hour before the operation. As a rule some form of preliminary narcotic, such as intra-rectal avertin or intravenous evipan should be given, which adds considerably to the patient's peace of mind.

Position of the Patient. The patient is placed on his side with the loin overlying the bridge of the table, or some support, such as an

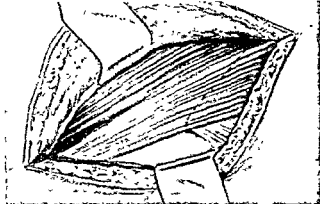


Fig. 1575.—EXPOSURE OF MUSCLES.

extending down to the iliac fossa. The incision is made through the skin and subcutaneous tissues, which are undercut on each side and well retracted until the muscles are exposed (fig. 1575), which consist of the latissimus dorsi and serratus posticus inferior at the posterior end of the wound, and the external oblique at the anterior extremity. The former two are cut across and the external oblique, together with the underlying internal oblique, is divided to a varying extent until the lumbar fascia is exposed, deep to which the twelfth dorsal vessels and nerve will be seen crossing from above downwards and forwards. In most cases these vessels will have to be picked up by two pairs of forceps, the lumbar fascia cut between them, and each end ligatured, together with all bleeding points that can be seen (fig. 1576). The retroperitoneal fat will extrude through the incision in the lumbar fascia, and, with two fingers inserted through the opening, the peritoneum is separated from the deep surface of the transversalis fascia and muscle, which are then cut through with scissors to any desired

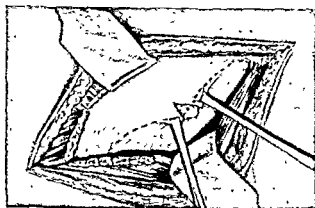


Fig. 1576.—INCISION OF LUMBAR FASCIA.

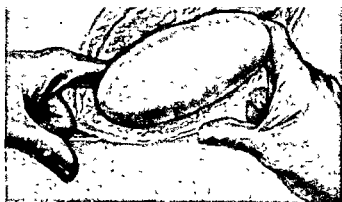


Fig. 1577.—MOBILISATION OF KIDNEY.

extent, together with as much more of the overlying external *internal oblique muscles as may be necessary.*

The eleventh intercostal vessels and nerve may be seen run between the two obliques, and should be preserved if possible by retracting them forwards. More room can be obtained at the upper end of the wound by cutting through the external arcuate ligament, which allows the twelfth rib to be retracted upwards.

In the anterior part of the wound will now be seen the kidney covered by peritoneum and extra-peritoneal fat, and in the posterior part the peri-renal fascia of Zuckerkandl. The latter is picked up with two pairs of long artery forceps and incised, exposing the yellow fatty capsule of the kidney. The opening in the fascia is enlarged upwards and downwards by splitting with two fingers, and the peri-renal fascia and fat are stripped forward together with the colon.

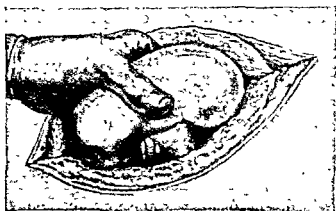


Fig 1578.—DELIVERY OF KIDNEY INTO WOUND

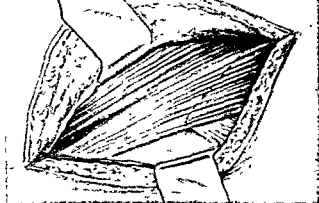


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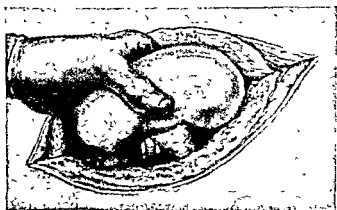


Fig. 1578.—DELIVERY OF KIDNEY INTO WOUND

...ing ... which is next freed from the perinephric tissues (fig. 1577) and delivered into the wound (fig. 1578).

Dense adhesions are sometimes encountered between the kidney and the peritoneum, some of which may require cutting with scissors and ligaturing. Care should be taken not to open the peritoneal cavity unless a view of the peritoneal aspect of the kidney is necessary, when the peritoneum is deliberately incised on the lateral side of the colon and later closed by a continuous catgut stitch. Further procedures will depend on the object of the operation.

Closure of the Lumbar Wound. Interrupted sutures of No. 3 chromic catgut are inserted through the full thickness of the muscles by means of large curved needles and clipped, care being taken not to miss the internal oblique which always retracts upwards under cover of the external oblique. In most cases a drainage-tube with a lateral opening is inserted at the junction of the vertical and horizontal limbs of the wound and arranged to lie behind the kidney. The bridge on the table is screwed down, the head of the table is raised, and the interrupted sutures are tied. A continuous suture of No. 2 chromic catgut unites the deep fascia overlying the muscles, and the skin is closed with interrupted fishing-gut eversion sutures. One skin stitch is passed through the drainage-tube. The wound is painted with picric acid, dressings are applied, and the patient is returned to bed.

GENERAL AFTER-TREATMENT OF OPERATIONS ON THE KIDNEY AND OTHER URINARY ORGANS

The post-operative care of a patient is best described under a number of headings, though it must be clearly understood that much depends upon the condition of the patient before operation, the exact nature of the operation itself, and the amount of shock which it has produced. An uncomplicated nephrectomy, for example, may require little more than ordinary careful nursing and the treatment of such symptoms as may arise. It is well, however, to have certain definite preconceived ideas which will be found invaluable, both for routine after-treatment and for dealing with any emergency.

(a) *Position of the Patient.* The patient should be placed flat on his back with only a small pillow under the head until consciousness has been fully regained. A constant watch must be kept on the respirations, especially if a preliminary narcotic, such as intra-rectal avertin,

has been used. If they become markedly slowed, 1 cc. of coramine should be immediately injected intramuscularly. As a rule an airway is left projecting from the mouth to prevent the possibility of suffocation from falling back of the tongue, and this airway should be removed only when the reflexes have returned, as shown by repeated attempts at swallowing or retching.

The subsequent position should be such that no tension is made in any way on the wound edges, and because the incision is in the loin it will be found that the greatest degree of comfort results from lying slightly on the sound side, as this tends to cause some bending of the trunk and approximation of the iliac crest and costal margin on the affected side. Further possible tension is removed by supporting the head and shoulders on pillows, which produces a slight forward bend of the body.

After some days the patient is allowed to assume a still more upright position and to roll over slightly on to the affected side.

(b) *Post-operative Pain.* On returning from the operating theatre a 10-oz. rectal saline containing 5 per cent glucose, 40 grs. of potassium bromide, and 30 grs. of aspirin should be given as a routine. When the patient has completely recovered from the anæsthetic, morphia $\frac{1}{4}$ gr. or heroin $\frac{1}{8}$ gr. may be injected intramuscularly, if necessary. A slightly smaller dose of these drugs may be repeated at six-hourly intervals, though in some cases a repetition of the same saline mixture is all that is necessary.

After any operation the intestine requires rest, which is ensured by the use of morphia or heroin; this is of far greater importance than the problematical risk of ileus, which has sometimes been attributed to the use of these drugs. After the first 24 hours, especially if no nausea or vomiting has occurred, the administration of empirin compound 10 grs. at 4- or 6-hourly intervals is often enough to counteract post-operative pain.

(c) *Post-operative Shock.* Shock may arise from prolonged operation, loss of blood, undue traction on the renal pedicle with involvement of the sympathetic nervous system, rough handling of the various layers of the abdominal wall, and loss of body heat. Pre-operative anxiety is also a potent factor. Where possible the best treatment for the condition lies in its prevention. The patient must be kept warm on the way to the operating theatre, while he is there, and

wound should be filled with hot saline before closing. On no account should the time taken over the operation be diminished at the expense of rough handling of the tissues. A large incision allowing of easy access to the kidney and its surroundings will always repay the surgeon. A skilled assistant, an efficient theatre staff, and a well-planned operation without undue hurry are all valuable assets. If post-operative shock is present in spite of the foregoing, the foot of the bed should be raised on blocks, and the patient kept warm with hot water bottles or a radiant heat cradle. A hypodermic injection of coramine 1 cc. should be given and fluids administered. In the minor degrees of shock rectal salines containing 5 per cent glucose at 2- or 3-hourly intervals are usually sufficient, but if the condition is grave, glucose-saline should also be administered subcutaneously, intravenously, or both, and no time lost in arranging for a blood-transfusion. Morphia $\frac{1}{4}$ gr. or heroin $\frac{1}{8}$ gr., by relieving pain and by quietening the patient, will do much to counteract shock.

(d) *Post-operative Fluids.* The administration of fluids constitutes a most important part of the after-treatment of all operations on the urinary system, as these are always followed by depletion of the blood volume, especially where there is some degree of renal insufficiency. Before the patient has recovered from the anæsthetic, fluids can be administered rectally or, if necessary, subcutaneously or intravenously. When he is fully conscious every effort should be made to encourage drinking, at first by small sips of iced water and later by larger quantities, depending upon the degree of post-operative flatulence or vomiting. The exhibition of fluids should be encouraged throughout convalescence and waters, such as Contrexéville or Vittel, will be found to be of great value.

(e) *Post-operative Medicinal Treatment.* In the absence of nausea or vomiting, an alkaline prescription to increase diuresis should be given as a routine until kidney function is fully re-established. If infection is present, alkalis should be followed by acids and a urinary disinfectant such as hexamine 10 grs. before meals. In most cases a suitable tonic, such as metatone (Parke, Davis & Co.) should be administered during convalescence, or tinc. ferri perchlor. 10 minims, added to the acid mixture, according to the following prescription :

R _y	
Tinc. ferri perchlor.	10 m.
Acid phos. dil.	} aa 8 m.
Acid nit. hyd. dil.	
Liquor strychninæ	3 m.
Spt. chlorof.	10 m.
Aqua.	ad ½ oz.

(f) *Post-operative Management of the Bowels.* During the first 48 hours after operation no attempt should be made to produce an action of the bowels. Occasionally, on account of manipulation of the large bowel during the separation of adhesions, excessive gas formation occurs after nephrectomy, and this may necessitate the passage of a flatus tube or the administration of a small enema, preceded by a hypodermic injection of $\frac{1}{2}$ cc. of pitressin $\frac{1}{4}$ hour previously. The essence of successful treatment of the bowel consists in the avoidance of stimulation, and on no account should purgatives in any form be given by mouth until an action has been obtained, either naturally or by an enema.

An enema is given 48 hours after operation, and is followed by the hypodermic injection of morphia $\frac{1}{4}$ gr. to counteract any degree of exhaustion which its administration may produce. If the result is unsatisfactory, a turpentine or ox-gall enema should be given 8 hours later, and if necessary repeated until an action is obtained. This is followed by an aperient such as 2 drachms of cascara evacuant or 2 vegetable laxative pills. When once the bowels have been opened, a regular action is ensured by the nightly administration of a smaller amount of cascara evacuant, followed, if necessary, by an enema the next morning.

(g) *Post-operative Flatulence and Vomiting.* Some degree of post-operative flatulence is common and is due partly to the swallowing of anæsthetic, and partly to the unavoidable manipulation of the kidney and its surroundings, but it usually subsides as soon as an action of the bowels is obtained. In some cases it may be more severe and lead to post-operative vomiting. Modern anæsthesia and gentleness in operating are important factors in its prevention. Should it occur to any marked degree the following remedies should be employed :

(1) A draught of hot water containing a teaspoonful of bicarbonate of soda is administered. This is usually promptly vomited, but by

acting as a stomach wash-out and removing mucus and swallowed anæsthetic, relief is often afforded.

(2) Three or four drops of iodine in half a wineglassful of water are administered at hourly intervals for three doses.

(3) Hewlett's mist. pepsinæ cum morphinæ co. is given in drachm doses at hourly intervals.

(4) Ten drops of adrenalin 1 in 1000 in half a wineglassful of water are administered hourly for three doses.

If not responding to any of the foregoing methods a stomach tube must be passed and the viscus washed out with weak bicarbonate of soda followed by weak potassium permanganate. The possibility of acute dilatation of the stomach must not be forgotten.

(h) *Post-operative Sleeplessness.* Sleeplessness following operation may be due to pain, distension of the bowel, or mental anxiety. The treatment of pain and the management of the bowels have already been discussed. During the first 24 hours sleep is usually ensured by the hypodermic injection of morphia or heroin, or by the rectal administration of aspirin and bromide in a glucose-saline solution. During the later stages of convalescence $7\frac{1}{2}$ grs. of medinal and 10 grs. of empirin compound are usually sufficient to ensure sleep. Soneryl or veramon may be used as substitutes for medinal. A hot drink before settling down, a comfortable position, and good nursing are all of importance.

(i) *Post-operative Retention of Urine.* If possible the patient should be induced to pass water within 12 hours of the operation, especially if there is a desire to micturate. A change of position or the applications of heat in the form of fomentations to the suprapubic region are usually effective, but if these simple methods fail, there should be no hesitation in passing a soft rubber catheter with strict aseptic precautions. If catheterisation has to be repeated, the bladder should be washed out with a mild disinfectant, such as acriflavine 1 in 8000.

(j) *Post-operative Hiccough.* This may follow operations on the kidney, especially if there has been perinephritis or a perinephric abscess, though it is commoner after operations on the lower urinary tract, such as prostatectomy. This symptom is most exhausting to the patient, and every effort should be made to arrest it. The remedies described for the treatment of post-operative vomiting should first be tried. Other measures include the slow sipping of water, the sucking

of a lump of sugar on which a few drops of chloroform have been poured, and the administration of dry food. In obstinate cases carbon dioxide inhalations and large doses of morphia $\frac{1}{2}$ gr. or heroin $\frac{1}{3}$ gr., combined with $\frac{1}{100}$ gr. atropine, should be given.

(k) *Post-operative Diet.* During the first 48 hours after operation only fluids or fluid food should be allowed. After the bowels have been opened the patient should be placed on a light diet which is gradually increased until full diet is attained about the tenth day. In the presence of some degree of renal insufficiency, protein food should be given most sparingly in order to avoid any extra strain on the kidneys. In calculous disease the stone should always be chemically analysed, and it should be remembered that certain foods are an ætiological factor in its formation. Brains, liver, sweetbreads and kidneys increase the uric acid content of urine, while rhubarb, spinach, tomatoes, strawberries and other berries predispose to oxaluria. It is wise, therefore, to omit some of these articles of diet as a permanent measure.

(l) *Post-operative Management of the Wound.* The management of the wound varies somewhat with the nature of the operation performed, and individual variations will be described under the different operations.

After nephrectomy with drainage for non-infective conditions and an apparently aseptic wound, the dressings are not, as a rule, disturbed for 48 hours, when they are gently removed, the wound painted with 3 per cent picric acid in spirit, and fresh gauze applied, especially around the drainage-tube. Excessive oozing of blood may necessitate additional packing. On the fourth day the wound is again dressed, the drainage-tube being removed either then or on the sixth day, according to the amount of discharge. The skin stitches are taken out on the tenth day and the wound well painted with antiseptic and re-dressed. On the following day a large piece of lint soaked in double strength lotio calaminæ co. is placed over the whole wound. This encourages healing and tends to relieve any irritation by its astringent and soothing properties.

If infection of the wound is present following evacuation of a perinephric abscess or other infective condition, and especially if much bruising has occurred from retraction of the wound, there is a great tendency for suppuration to occur in the subcutaneous fatty tissue, and this is further aggravated by the presence of the stitches which act as a foreign body. The condition is usually evidenced by redness of the

surrounding skin edges and the discharge of purulent fluid between the stitches, and is accompanied by constitutional disturbances and pain. A large fomentation of gauze soaked in eusol should be applied, and the surrounding skin painted with a mixture of zinc oxide and castor oil (equal parts). Any sinuses must be probed in order to free localised collections of pus, and in the later stages of healing double strength calamine lotion is applied. In such cases the drainage-tube is retained for a longer period than usual.

NEPHRECTOMY

Indications. (1) Unilateral renal tuberculosis. (2) Advanced calculous pyonephrosis. (3) Advanced hydro- or pyo-nephrosis. (4) Malignant disease. (5) Extensive injury. (6) In some cases of solitary cyst and hydatid cyst. (7) In some cases of urinary fistula following operation on the kidney.

Lumbar Nephrectomy. In the majority of cases nephrectomy is carried out by the lumbar route, the preparation of the patient, the anæsthetic, the position, and the preliminary steps of the operation being conducted as previously described. If dense adhesions exist, the

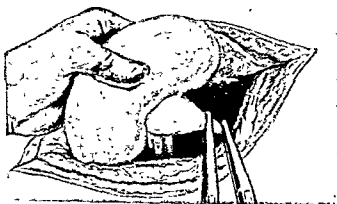


Fig. 1579.—NEPHRECTOMY LIGATURE OF URETER BETWEEN CLAMPS.

ureter should first be exposed at the lower pole of the kidney, stripped up by gauze dissection, and clamped at as low a level as possible by two curved Spencer Wells forceps, and a piece of gauze passed behind them (fig. 1579). The ureter is cut across with a knife between the two forceps and each end touched with pure carbolic acid. The lower end is ligatured and allowed to drop into the depths of the wound after removal of

the forceps. Using the upper end of the ureter as a guide, the kidney is separated from its surroundings by division of all adhesions with blunt dissection, or by means of gauze stroking. If very dense, some of these adhesions will require ligature and division with scissors. The fatty capsule is next stripped off the anterior surface of the kidney and renal pedicle by means of dry gauze swabs and the suprarenal capsule separated at the upper pole. At this point difficulty may be encountered in the complete stripping of the peritoneum. At a lower level the colon may be adherent to the anterior surface of the kidney and will require careful removal. It should be borne in mind that on the right side the second part of the duodenum is in intimate relation to the pedicle.

The kidney is next turned over to the front and the vascular pedicle and renal pelvis are stripped on their posterior surface (see fig. 1578). It is a great advantage to ensure that the pedicle is reduced to a small size by careful removal of any fat, adherent peritoneum, and lymphatic



Fig. 1580.—WINSBURY-WHITE'S RENAL PEDICLE NEEDLE.

glands, and if this is efficiently carried out it will be found that the kidney is quite free from its surroundings, being held only by its pedicle. The pedicle needle (fig. 1580) threaded with No. 4 catgut is gently insinuated between the vessels and a ligature firmly tied round half the pedicle (fig. 1581). The free ends of this ligature are next tied round the whole pedicle and left long. A clamp is applied $\frac{3}{4}$ inch distal to the ligature, the pedicle divided with curved scissors immediately on the proximal side of the clamp, and the kidney removed. The cut end of the pedicle is carefully examined for any possible bleeding point and is allowed to drop back into the wound after cutting the ends of the ligature. If much thickening of the perinephric fatty tissue is present as a result of tuberculous disease of the kidney, as much of this as possible should be removed. If nephrectomy is being carried out for malignant disease, an attempt should be made to remove all this perinephric fat. In these cases much hæmorrhage may occur from the large veins which are so commonly associated with the condition. Except in certain cases of tuberculous disease the wound is closed with drainage which, together with the general after-treatment, has already been described.

An alternative way of dealing with the renal pedicle is by Thomson-Walker's clamp and double ligature method. This will be found of advantage when the pedicle is short or is much thickened by inflammatory matting.

A curved or angled pedicle clamp with blades widely separated is slipped round the pedicle as near the kidney as possible, and securely clamped. The kidney is cut away, care being taken to leave a fringe of pedicle, and a ligature of No. 4 chromicised catgut is tightly tied round the pedicle. A second ligature is placed round the pedicle proximal to the first and the first double knot is tied. The clamp is opened slowly and the knot still further tightened.

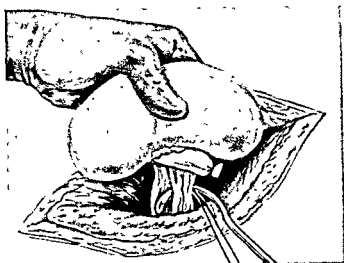
The first ligature bunches the constituents of the pedicle as far as the clamp will allow, and as the latter is loosened the second ligature closes them up still further and secures adequate hæmostasis (fig. 1582). The clamp is next removed and the second knot tied when it will often be found that the first ligature is quite loose. A third knot is tied and the divided end of the pedicle carefully examined before cutting the ends of the ligature.

Complications During and Following Nephrectomy. (1) Difficulty may be encountered in a fat patient if the space between the twelfth rib and the iliac crest is narrow. In these cases the twelfth rib can be retracted upwards by cutting the external arcuate ligament with scissors. Care must be taken not to injure the subcostal vessels, which are difficult to ligature in this situation. If cut they are best secured by a piece of fine catgut threaded on a curved needle, which is passed round them and tied.

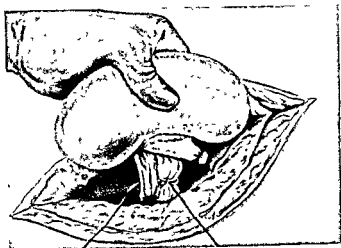
(2) Difficulty may arise from dense and numerous adhesions, a distended colon and a short vascular pedicle. A large incision, good retraction and lighting, and gentle handling do much to render the operation easier.

(3) The peritoneum may be injured if care is not taken to separate it from the abdominal wall before the muscles are cut. It may also be torn while separating dense adhesions between the kidney and the peritoneum, especially in secondary operations on the organ. Once the peritoneal cavity is opened the abdominal aspect of the kidney should be examined. If this constitutes a necessary part of the operation, the peritoneum is best incised on the outer side of the colon.

(4) Injury to bowel. The colon on both sides and occasionally the second part of the duodenum on the right side may be injured during their separation from the kidney if dense adhesions are present.



A.



B.

Fig. 1581.—NEPHRECTOMY: LIGATURE OF RENAL PEDICLE WITH THE AID OF A PEDICLE NEEDLE. A. SUTURE BEING PASSED THROUGH PEDICLE. B. LIGATURE ROUND HALF THE PEDICLE TIED.

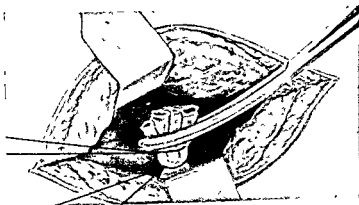


Fig. 1582.—NEPHRECTOMY: LIGATURE OF RENAL PEDICLE BY THOMSON-WALKER'S CLAMP AND DOUBLE LIGATURE METHOD.

Sloughing of the bowel wall may follow, and is usually fatal in the case of the duodenum. If the colon is involved, spontaneous closure may occur as the wound heals, but occasionally a faecal fistula is established, which is best dealt with transperitoneally at a later date.

(5) Injury to the pleura occasionally occurs when the twelfth rib is very short, and is shown by air being sucked in and out of the wound during respiration. It is most likely to occur when nephrectomy is being performed for a malignant growth. If the opening is small it is unnecessary to suture it. An aberrant renal artery may be torn, but this is a rare complication. Profuse hæmorrhage may occur from slipping of the ligature round the renal pedicle, though if the latter is transfixed and ligatured in two bundles this accident cannot happen. The cases that have been reported have usually occurred when the pedicle is divided between clamps and ligatured *en masse*. Tearing of the inferior vena cava may result from undue traction on the pedicle, but this can be controlled by pressure, and the rent sutured with fine catgut.

(6) Uræmia. This is a rare condition, and should not occur if adequate pre-operative investigation is carried out, especially in regard to the functional capacity of the opposite kidney.

PARTIAL NEPHRECTOMY

Indications. (1) Bifid kidney and pelvis in which only one part is diseased. (2) Certain cases of laceration of the kidney where the greater part of the organ is uninjured. (3) Localised disease, such as solitary cyst or abscess. (4) Stones in a dilated lower calyx.

Except in some cases of double kidney, a wedge-shaped excision is made which includes the affected portion of the organ. Deep mattress sutures of No. 2 chromicised catgut are inserted, drawing the two raw areas together over a piece of muscle, and these are further united by a continuous fine suture of No. 1 chromicised catgut which includes the fibrous capsule. The wound is closed with drainage.

TRANSPERITONEAL NEPHRECTOMY

This method of approach to the kidney is but rarely used, and then only for very large renal tumours, or for injuries of the kidney where it is suspected that other abdominal viscera are involved. If performed for malignant disease, it is important to ligature both the renal vein and

the renal artery close to their junction with the inferior vena cava and aorta and to remove as much glandular tissue as possible in that vicinity. The best incision is a T-shaped one, the horizontal limb stretching from just below the 11th rib to a point 2 inches above and $\frac{1}{2}$ inch to one side of the umbilicus. The vertical limb of the T is a paramedian incision. The horizontal incision divides the abdominal muscles and the front wall of the rectus sheath. If necessary the rectus muscle is drawn in or divided at the tendinous intersection found in this situation. The vertical limb incises the rectus sheath $\frac{1}{2}$ inch from the middle line, and the rectus muscle is turned outwards with the abdominal muscles. The peritoneal cavity is opened and the abdomen, liver, and renal pedicle are carefully examined to determine whether the renal growth is operable. The colon and other abdominal viscera are then packed off. The posterior parietal peritoneum near the inner border of the kidney is opened by a long vertical incision on the outer side of the colon, care being taken not to damage the latter or the duodenum on the right side. By stripping the peritoneum inwards, and any fat or glands in this situation outwards, the renal vessels and ureter are brought into view and are ligatured separately and divided. The peritoneum overlying the kidney is incised circularly and the organ freed by blunt dissection, keeping as far away from it as possible. The suprarenal gland is usually included. The kidney is thus removed complete with its fatty and peritoneal investment. A stab wound is made through the loin at the outer border of the quadratus lumborum muscle and a drainage-tube inserted. The posterior parietal peritoneum is mobilised and sutured and the abdominal wound is closed in layers.

NEPHROPEXY (THOMSON-WALKER'S METHOD)

After exposing the kidney the fat is cleared from the posterior abdominal wall and from the surface of the quadratus lumborum and psoas muscles by dry gauze stroking. The kidney is delivered and turned forwards. The capsule is excised over an area of the posterior surface extending from pole to pole, and from the hilum to within 1 inch of the convex border (fig. 1583). The capsule is gently stripped backwards from the edge parallel to the outer border of the kidney towards the hilum, and then cut away. Three sutures of No. 4 chromic catgut are passed through the kidney substance $\frac{3}{4}$ inch from the convex border and within the area of the attached capsule (fig. 1584). The upper

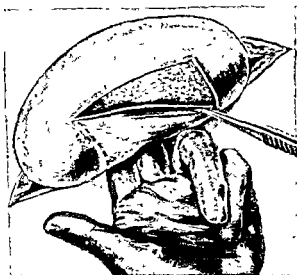


Fig. 1583.—NEPHROPEXY. EXCISION OF PORTION
OF CAPSULE.
(After "*Modern Operative Surgery*.")

suture lies near the upper pole, the intermediate about the middle of the convex border, and the lower near the lower pole. The kidney is replaced in the wound and carefully fitted into the position in which it most easily lies, care being taken that the upper pole is not tilted outwards, and that there is no kinking between the pelvis and ureter. By means of large curved needles the upper suture is passed through the structures at the angle of the last rib and erector spinæ muscle and tied. The posterior ends of the middle and lower sutures are passed through the outer edge of the quadratus lumborum muscle and tied to the anterior ends. The wound is closed with a drain passing to the anterior surface of the kidney near its lower pole.

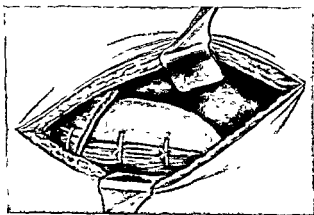


Fig. 1584.—NEPHROPEXY: POSITION OF SUTURES.
(After "*Modern Operative Surgery*.")

NEPHROTOMY

Indications. (1) In some cases of hydronephrosis where nephrectomy is contra-indicated. (2) In some cases of pyelonephritis and pyonephrosis. (3) In some cases of calculous anuria.

After the kidney has been exposed a small incision is made over its convex border and a finger passed into the renal pelvis. A tube of similar size is then inserted through the incision into the renal pelvis and fixed by a stitch which is passed through the tube and the fibrous capsule. The wound is closed after placing a second tube near the kidney to drain the perinephric tissues. In calculous anuria a rapid search should be made for the obstructing calculus, which should be removed if possible, but no prolonged search is justifiable.

After-Treatment. The general after-treatment has been described on page 2824. All measures which will tend to promote renal secretion, such as rectal, subcutaneous or intravenous salines, are immediately instituted. In septic cases lavage of the kidney is performed daily through the tube. In pyonephrosis an attempt should be made to open up all loculi before the tube is inserted into the renal pelvis. The nephrotomy tube is left in position for about ten days. When the patient's condition is satisfactory and the opposite kidney proves to be sound, a secondary operation, such as nephrectomy or the removal of all obstructing calculi, is carried out. If the nephrotomy is a permanent one, as in the case of a solitary pyonephrotic kidney, a permanent apparatus is necessary for the collection of urine. The drainage-tube is replaced by a smaller one which is led into a receptacle strapped to the patient's waist.

PYEOLITHOTOMY

Pyelolithotomy is the operation of choice for removal of a renal calculus through an incision in the renal pelvis. By this means a minimum amount of damage is inflicted on the renal tissue, and convalescence is more rapid and less subject to complications.

Indications. (1) A stone free in the renal pelvis. (2) A stone in a calyx where the channel communicating with the pelvis is sufficiently large to enable the stone to be coaxed into the pelvis and thus be extracted. (3) A stone in the upper end of the ureter.

Certain conditions are necessary for the operation of pyelolithotomy

to be carried out: The kidney must be capable of delivery into the wound, which is only possible if all adhesions can be removed, if the pedicle is long enough, and if the space between the costal margin and the iliac crest is of sufficient width. The use of Irwin's right-angled pyelolithotomy forceps (fig. 1585) will greatly facilitate the extraction of the calculus, especially in difficult cases.

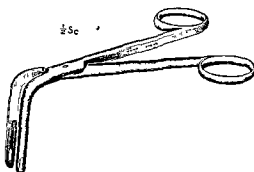


Fig. 1585.—IRWIN'S PYLELITHOTOMY FORCEPS

The preparation of the patient, anæsthesia, position and the preliminary steps of the operation are described on page 2819. The kidney, freed from adhesions, is drawn out of the wound, turned upwards and forwards over its upper margin and retained in this position by two strips of gauze which are passed round its two poles and are held by an assistant (fig. 1586). The fine fibro-fatty tissue adherent to the posterior wall of the pelvis is removed by gauze stroking

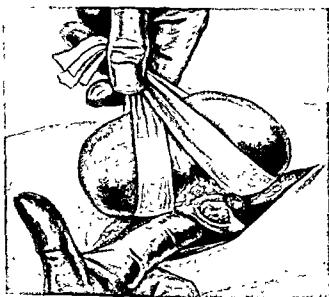


Fig. 1586.—PYELOLITHOTOMY.

until the stone can be seen bulging through its wall. By placing the index finger behind the pelvis its projection is still further increased. A narrow strip of gauze is threaded behind the renal pelvis and upper ureter to prevent extravasation of urine, and with a fine scalpel the posterior wall of the pelvis is incised in its long axis, the length depending upon the size of the calculus. By means of Irwin's pyelolithotomy forceps the latter is carefully removed, especial care being taken to avoid breaking off any fragments which might be overlooked and form the nucleus of another stone. If possible, the little finger is gently introduced into the wound and the pelvis and calyces are explored. In the event of the calyces being of insufficient size to allow of this manner of exploration, a malleable probe, bent at an angle, is introduced into each calyx in turn and its cavity sounded.

If preliminary pyelography excludes a secondary stone in the calyx, this procedure is unnecessary, as is also the passage of a ureteric catheter down the ureter to exclude a calculus. If the pelvic incision is large, its edges are united with fine plain catgut, care being taken not to include the mucous membrane, as this would predispose to a deposit of crystals on the ligature which is not absorbed for some time because of the lack of vascularity of the pelvic wall. A small incision need not be sutured at all. The wound is covered, if possible, by a quantity of the fibro-fatty tissue in the vicinity, which is retained in position by a fine stitch. The kidney is replaced in position, and a small drainage-tube with a lateral eye inserted so as to lie in contact with the posterior wall of the pelvis. A careful search is made for bleeding points, all clots or torn perinephric tissues are removed, and the wound is closed in layers.

After-Treatment. The general after-treatment is described on page 2824. The tube is removed on the fifth to seventh day, according to the amount of oozing present, and healing is usually complete by the fourteenth day.

Complications. (1) If delivery of the kidney is not possible, but a finger will reach the pelvis at the depths of the wound and can palpate the calculus, a small incision is made over it, the stone extracted and no attempt made to suture its margins. A larger drainage-tube is employed. (2) Lack of or imperfect drainage will lead to extravasation of urine into the perinephric tissues, and if infected will give rise to spreading infection. Hiccough, distension of the colon, and fever are common, and may lead to exhaustion of the patient. Spontaneous

improvement may result from a sudden gush of blood-stained foul-smelling urine, but early opening and free drainage of the wound should not be delayed. (3) In a few cases a fistula may form in the loin, due to obstruction in the ureter, usually at the pelvi-ureteral junction, sepsis, or lack of drainage. Any of the complications described on page 2832 as following nephrectomy may also occur after pyelolithotomy.

NEPHROLITHOTOMY

Nephrolithotomy consists of the removal of one or more calculi by an incision through the renal cortex.

Indications. When preliminary investigation proves that the calculus is inaccessible by pyelolithotomy, e.g. (a) A stone in a calyx which has led to its dilatation and narrowing of its communication with the renal pelvis. (b) A large branched calculus in which nephrectomy is contra-indicated owing to disease of the opposite kidney.

The kidney is mobilised and drawn as far as possible out of the wound. The pyelogram, mounted on an illuminated screen, should be at hand. In the case of a single stone the kidney is held with the left hand, and the renal pedicle is compressed between the first and second fingers; a small incision is made over the calculus and the latter gently withdrawn with stone forceps. Its shape and size are carefully compared with the X-ray, and if any suspicion arises as to whether it is intact, the distended calyx, and if necessary the pelvis, must be carefully explored with the forefinger or a probe. In the case of multiple stones, several incisions may be necessary and the number of calculi, together with their shape and size, must be compared with the radiogram. In the case of a small stone which does not lie near the surface and is impalpable, Thomson-Walker advises the use of a small grooved probe which is pushed through the kidney capsule in the line of the posterior calyces, and a little behind the convex border of the kidney at a point overlying the calculus, as judged by the X-ray. Probing is continued until grating is felt, when a small incision is made with the scalpel along the groove of the probe and the calculus removed with stone forceps. If the incision in the kidney is reasonably small, it is closed by the insertion of one or two interrupted mattress sutures to arrest bleeding, followed by a continuous stitch which picks up the renal capsule. If the incision is large and especially if a marked degree of sepsis is present, a tube should be inserted through it into the pelvis and left in position for at least six days, and irrigation of the pelvis carried out through it.

A drainage-tube is placed down to the posterior aspect of the kidney and the wound closed in layers.

Complications. Any of the complications described on page 2832 during and following nephrectomy may occur, and in addition hæmorrhage. This may arise during the operation, but is easily controlled by compression of the renal pedicle during insertion of the mattress sutures. If the incision into the kidney is large, it is wise to insert a small muscle graft before inserting the stitches. If bleeding continues on releasing the pressure on the pedicle, additional mattress sutures should be inserted. Occasionally even these are insufficient for its control, when nephrectomy must be performed, provided previous investigation has shown that the opposite kidney is healthy. Hæmorrhage occurring after operation may be either reactionary or secondary in type. If severe, the kidney must be explored, and if bleeding is not readily controlled by suture, nephrectomy must be carried out.

After-Treatment. The general after-treatment is described on page 2824. On the third day the patient is propped up to encourage drainage of urine down the ureter. Rest in bed for three weeks is essential to ensure sound healing of the muscles. Dressings are changed as soon as they become soaked. The tube is removed on the fourth to eighth day, depending upon the amount of oozing or escape of urine. Suppression of urine occasionally occurs and must be energetically treated by fluids, diuretics, hot fomentations, or radiant heat to the renal areas.

VON LICHTENBERG'S PLASTIC OPERATION FOR HYDRONEPHROSIS

by

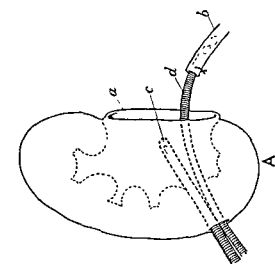
Victor W. Dix

The kidney is exposed by the incision described on page 2821, which for the purpose of this operation must be adequate. When the kidney has been exposed, it is freed from the perinephric tissue and a complete dissection of the renal vessels and the upper part of the ureter is made. If it appears that the hydronephrosis has been due to kinking of the ureter over a vessel, it may be possible to divide the ureter below this point and to re-implant it into the reconstructed pelvis on the other side of the obstructing vessel. This avoids the necessity of dividing the vessel, which always causes necrosis of a certain amount of renal tissue. If there is any perinephritis and peri-ureteritis, the fibrous strands must be carefully divided until the pelvis and the ureter are completely bare and free from adhesions. It is sometimes difficult to decide at this stage whether the kidney has enough secreting

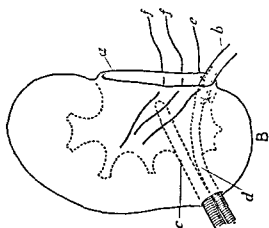
substance left to be worth saving, but it is surprising how much function will return to an apparently useless kidney as the result of drainage and reconstruction of the pelvis.

The operation itself is performed as follows: The ureter is divided at its junction with the pelvis or, if there is an obstruction at the uretero-pelvic junction, a little below this point. Either before or after the division of the ureter the pelvis is opened, between two traction sutures, by an incision running in the line of the ureter towards the kidney. The ureter is held by one suture which was inserted before it was divided. The pelvis can at this stage be trimmed and the superfluous pelvic tissue removed. It is usually convenient to remove most of the posterior surface and perhaps some of the anterior surface, too, if the pelvis is very large. A pair of curved forceps is now inserted through the opened pelvis into the lower main calyx and out through the kidney substance, and two whistle-tipped rubber catheters, a No. 16 and a No. 12 Charrière, are grasped by the forceps, and are drawn back through the kidney substance into its pelvis. The larger catheter is allowed to lie in the open pelvis and the smaller catheter is pulled further through and inserted into the upper end of the ureter for a distance of about 1.5 cm. A suture is then passed through the catheter and the ureter, fixing the catheter in the lumen of the ureter. This suture should be somewhere in the first centimetre of the ureter. As soon as the catheter is fixed it is pulled gently back until the upper end of the ureter lies inside the opened pelvis. About one centimetre of the ureter should lie in the pelvis at its lowest point, usually in the neighbourhood of the old uretero-pelvic junction. A suture is then passed, picking up first one wall of the divided pelvis, next the wall of the ureter, and then the other wall of the divided pelvis. When this suture is tied on the posterior surface it will be obvious that the ureter is firmly attached to what will be the lower angle of the new pelvis. At this stage the ureter and the pelvis may be rotated and another suture inserted on the anterior surface as an extra safeguard, but this is not absolutely necessary. The No. 16 catheter is then adjusted until it lies comfortably in the new pelvis and the latter is reconstructed by suturing together the cut edges. The two catheters are now fixed separately to the capsule of the kidney by passing one suture through each catheter and the capsule of the kidney (fig. 1587).

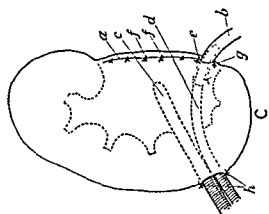
Care must be taken when passing these sutures not to pull the catheters out owing to the resistance of the rubber tube to the passage of the needle. If the kidney lies well when replaced in its cavity, and apparently without excessive movement, nothing further need necessarily be done. If, however, the kidney seems to move freely with the diaphragm, or if the vessels are loose, thereby allowing the kidney a large range of movement, it is better to fix it at this stage. This can be done by decapsulating the upper two-thirds of the kidney, pushing it up under the rib, and fixing it in this position by a simple suture passed through its lower pole and attached to the upper angle of the wound. A corrugated rubber drain is placed outside the kidney in contact with the suture line in the reconstructed pelvis. The abdominal wall and skin are then sutured in the ordinary way and the two catheters fixed at their points of exit from the wound. It will be seen that the No. 16 catheter, which is the main drainage catheter and on which the success of the operation depends, is attached at two points, namely, at its exit from the kidney where it is attached to the capsule, and also at its exit from the skin. The catheter in the ureter is fixed at three points; there is one suture attaching it to the ureter itself, another attaching it to the capsule of the kidney where it leaves its posterior border, and a third suture attaching it to the skin. Before the abdominal wall is sutured, the reconstructed pelvis should be tested to see whether



- a*—Cut edge of pelvis.
b—Ureter.
c—10 F catheter in pelvis.
d—12 F catheter sutured into ureter.



- a, b, c, d*, as in A.
e—First suture attaching ureter to lower angle of pelvis (not tied).
ff—Sutures through cut edge of pelvis (not tied).



- a, b, c, d*, as in A.
e—First suture attaching ureter to lower angle of pelvis (tied).
ff—Sutures through the edges of the pelvis (tied).
g—Extra suture attaching ureter to new pelvis.
h—Sutures attaching each catheter separately to renal capsule.

Fig. 1087.—VON LICHTENBERG'S PLASTIC OPERATION FOR HYDRONEPHROSIS.



Fig. 153a.—R.R. FEMALE. AGED 19. OCTOBER 7TH, 1932.
Left Pyelogram - BEFORE OPERATION.



Fig. 153b.—AUGUST 17TH, 1933. *Left Pyelogram SAME CASE 9 MONTHS AFTER OPERATION.*

it is watertight. This is done by injecting not more than 3 or 4 cc. of normal saline into the pelvis through the larger catheter.

The after-treatment is the same as that of any other kidney operation, with one exception. During the first few days after the operation, and particularly during the first twenty-four hours, the very greatest care must be taken that the drainage-tube does not become blocked. There is often a little bleeding into the pelvis from its cut edges, or from the hyperæmic mucosa, and small clots may form which block the holes of the catheter. If this obstruction is not removed the pressure inside the pelvis becomes so great that the stitches may give way, and the success of the operation will then be ruined. The catheter should therefore be examined every hour during the first twenty-four hours, and every two hours for the next forty-eight hours. At the end of this time the urine is usually no longer even faintly blood-stained, and no complications are likely to occur. Should the tube become blocked, it can easily be cleared again by gentle syringing with normal saline, or suction applied with the syringe may also help to clear it. Any amount up to 4 cc. can with safety be injected into the re-made pelvis. The corrugated rubber drainage-tube can be removed on the eighth to tenth day, and the two tubes that are in the kidney itself may be removed between the tenth and fourteenth days. On the tenth day the skin stitches should be removed and a *gentle* effort made to pull out the tubes. If they are loose they will come out easily, but if they are still attached to the renal capsule no force should be used, and a further gentle pull should be made each day when the dressing is done until they come out readily. There is usually no leakage of urine after the catheters are removed, but should this occur it will not last for more than two or three days.

The above operation is in principle the same as that performed by Professor A. von Lichtenberg of Berlin, who has done so much to encourage conservative renal surgery.

CHAPTER III

DISEASES OF THE URETER

INJURIES OF THE URETER

(1) *Rupture.* Rupture of the ureter alone due to external injury is a rare condition. As a rule there is an associated laceration of the kidney (see page 2756). The ureter may be partly or completely torn across, but the peritoneum is not usually implicated.

Symptoms and Signs. Shock is a marked feature during the early stages, and is accompanied by pain and tenderness which pass off in a few days if the injury is uncomplicated. Later, a gradually increasing fluid swelling appears in the loin and there is a diminution in the amount of urine passed. Hæmaturia does not occur. After a time infection of the extravasated urine may take place and the usual signs of suppuration become superimposed.

Treatment. Immediate diagnosis after accident is impossible, but a gradually increasing swelling must be treated by exploratory incision. If only a partial tear of the ureter has occurred, it is sufficient to close the wound with drainage, a ureteric catheter being passed to the kidney at the time of operation and left *in situ* for three days. A permanent fistula may, however, remain or a hydronephrosis develop from obstruction of the ureter by fibrous tissue. If the rupture is complete, an attempt may be made to suture the two ends of the ureter together over a ureteric catheter, which is passed from the bladder before commencing the operation and left in place for three days. This is best performed by the oblique end-to-end method (see page 2874). If suture is impossible, the upper end of the ureter may either be ligatured, when atrophy of the kidney will occur, or the organ removed, provided the function of the opposite kidney has been proved to be satisfactory.

(2) *Operative Injury.* The ureter is occasionally injured by forceps during delivery, but more commonly in the course of operations on the uterus and its adnexa. It may be partly or completely cut across during

Wertheim's operation, or a portion of its wall may slough at a later date from deprivation of its blood supply.

During a total hysterectomy it may be included in a ligature or pricked by a needle during control of hæmorrhage at the lateral margins of the vaginal vault. Similar damage to the ureter may also occur during Kelly's hysterectomy and during vaginal hysterectomy. The usual result is a fistula which commonly opens into the vaginal vault, or, rarely, into the abdominal wound.

Symptoms and Signs. Some days or weeks after a hysterectomy the patient is observed to have incontinence, and on examination urine is seen to emerge from the vagina. Indigo-carminc injected intravenously appears from one ureteric orifice in the normal manner, but on the opposite side there is either no efflux or a marked delay is observed in the appearance of the dye. A cotton wool swab placed in the vagina is found to be stained blue, thus confirming the presence of a fistula. Intravenous pyelography, especially in late cases, demonstrates some dilatation of the kidney and that part of the ureter proximal to the obstruction.

The exact position of the injury is ascertained by passing a bougie up the ureter and noting the distance from the ureteric orifice to the site of obstruction.

Treatment. (a) *Immediate.* Unfortunately injury is rarely diagnosed during operation, as in all hysterectomies other than Wertheim's the ureter is not exposed, since ligatures and stitches are applied at a reasonably safe distance from its supposed course.

When exposed and cleared during Wertheim's operation, a partial or complete cut will be followed by a flow of urine.

Treatment of the injury will depend on its extent. Partial section is best left alone, a drainage-tube being passed extra-peritoneally to the site of injury.

Complete section requires anastomosis of the cut ends, and this is best effected by the oblique end-to-end method (see page 2874), with extra-peritoneal drainage to the site of injury. In both types of injury, contraction must be prevented by the intermittent passage of ureteric bougies or catheters. In some cases the distal extremity of the upper end of the ureter is best transplanted into the bladder (see page 2875) through a small puncture incision, the viscus drained by an indwelling catheter, and a drainage-tube passed extra-peritoneally to the site of anastomosis.

(b) *Remote.* An attempt should be made to pass a fine ureteric bougie up the ureter past the obstructed portion of the tube. If this succeeds, increasing sizes of bougies are used until finally a large ureteric catheter can be passed to the kidney. This is left in situ for several days and is followed by intermittent dilatation of the ureter for some months.

Should this method of treatment fail, the upper end of the ureter should be exposed by an extra-peritoneal incision and traced down to the seat of obstruction. An attempt should then be made to anastomose the ureter to the bladder, although this is usually impossible owing to the shortness of the tube, in which case one of two procedures can be adopted. If the opposite kidney is healthy, nephrectomy should be performed. In other cases, the lower end of the upper part of the ureter should be brought out through the upper end of the wound and a permanent fistula established in the loin.

CONGENITAL ABNORMALITIES

Double ureter is associated with a bifid pelvis of the kidney. As a rule the ureter which drains the upper portion of the kidney opens at a lower level on the trigone than the ureter which drains the lower part. In itself this condition is of no clinical importance and may only be discovered accidentally during routine cystoscopy (fig. 1589). In some cases the two ureters unite with the formation of a single tube which may either enter the bladder in the normal situation or be ectopic and open in the male into the seminal vesicle or prostatic urethra, and in the female into the urethra or vagina, giving rise to incontinence of urine. In rare cases a supernumerary ureter may end blindly in some part of the bladder wall with formation of a cyst, or its opening be contracted, with resulting atrophy or hydronephrosis of the corresponding part of the kidney. Occasionally that part of the kidney drained by one of the ureters may be diseased, but this is in no way due to the congenital abnormality present. As has been described under "Abnormalities of the Kidney," it is sometimes possible to perform a hemi-nephrectomy for the relief of the condition.

In solitary kidney the ureteric orifice may be displaced towards the mid-line, and in an atrophic kidney be functionless though situated in its normal position.

Treatment. See page 2753.

URETERIC STRICTURE

Stricture of the ureter may be either congenital or acquired.

(a) Congenital stricture occurs either at the pelvi-ureteral junction or at the ureteric orifice (pin-hole meatus, fig. 1590), and if untreated may give rise to hydronephrosis or atrophy of the corresponding kidney.

(b) Acquired stricture may follow laceration of the ureter due to trauma, injury due to impaction of a ureteric calculus (especially if the latter has been removed by operation), or involvement of the tube during gynaecological operations.

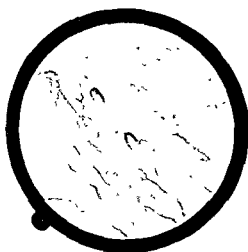


Fig. 1589.—DOUBLE RIGHT URETERIC ORIFICE.

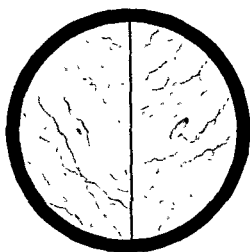


Fig. 1590.—PIN HOLE RIGHT URETERIC ORIFICE AND NORMAL LEFT URETERIC ORIFICE.

(c) The ureter may be involved by growths which invade it from without, such as carcinoma of the uterus or ovary.

(d) Stricture of the pelvi-ureteral junction is a common sequel to ascending lymphatic spread from infections of the genital apparatus in either sex. This contraction is due to kinking of the ureter at its junction with the pelvis and its fixation in an abnormal position by inflammatory adhesions. (See Hydronephrosis, pelvic type.)

Symptoms and Signs. These are due to the back pressure effects produced on the kidney with resulting atrophy, or hydro- or pyonephrosis.

Treatment. (1) Pin-hole meatus (fig. 1590). An attempt should be made to pass a small ureteric bougie. If this succeeds, intermittent dilatation will usually result in a cure. An alternative method is to insert one

Cystoscopic Appearances. The mucous type, which is the more common, appears translucent, with clearly defined blood-vessels radiating over its surface (fig. 1593). In the muscular type the cyst is opaque while the blood-vessels are fewer in number and less clearly defined. In both varieties the cyst will be seen to swell up suddenly owing to distension of its lumen by a peristaltic rush of urine. Next follows a small prolonged efflux through the contracted opening with gradual shrinking in size of the cyst, which assumes a convoluted worm-like appearance when completely empty (fig. 1594). The cycle recommences with a further rush of urine from the kidney. If the bladder is over-distended, the cyst is unable to expand because the intravesical pressure is greater than the intra-ureteric. The ureteric orifice is

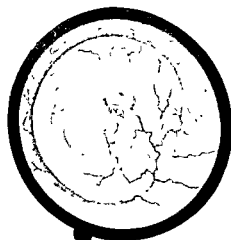


Fig. 1593.—URETEROCELE DISTENDED.



Fig. 1594.—URETEROCELE COLLAPSED.

situated in the centre of a small nipple which does not take part in the general expansion. It is usually on the summit of the cyst where it is readily seen, but may be posterior and only come into view when the ureterocoele is collapsed.

Treatment. In the past this varied from simple slitting of the cyst to complete resection with or without circular suture of the two mucous layers, after preliminary suprapubic cystotomy.

The modern treatment, however, consists of diathermic destruction of its wall by means of a terminal introduced through a cystoscope (fig. 1595). The coagulation should be effected in a circular manner and an attempt made to perforate the cyst wall so that urine may have a free passage into the bladder (fig. 1596). This is by no means always possible for the cyst soon tends to collapse from reflex inhibition of renal secretion,

thus making the application of the electrode a matter of great difficulty. The ureteric orifice and a small area immediately surrounding it should be avoided, as coagulation of the papilla will cause almost certain occlusion of the orifice and lead to a complete block of the ureter for some days, with consequent damage to the kidney and marked renal pain. The cyst wall sloughs away in about ten days, leaving a much enlarged ureteric opening. At the end of six weeks the orifice appears almost normal except for a slight permanent enlargement.

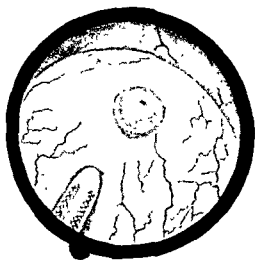


Fig. 1593.—APPLICATION OF DIATHERMY
TERMINAL TO URETEROCELE.

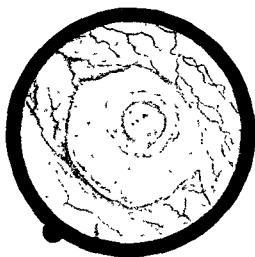


Fig. 1596.—URETEROCELE COLLAPSED AFTER
DIATHERMY TO ITS WALL.

In the presence of gross complications, such as a large hydronephrosis, extensive inflammatory changes, or calculous formation, nephrectomy or nephro-ureterectomy may be necessary, provided the opposite kidney is healthy.

GROWTHS OF THE URETER

Ureteric growths resemble those which arise from the renal pelvis, the commonest variety being a papilloma which tends to become malignant. In most cases it is secondary to a similar growth of the pelvis which has spread down the tube. Only rarely is the ureter the primary site. Extension occurs downwards with protrusion of the growth through the ureteric orifice into the bladder. Columnar-celled carcinoma has also been described with formation of a nodular growth which spreads rapidly to the surrounding structures and gives rise to metastases. Obstruction of the ureter will produce varying degrees of hydronephrosis, which later may become infected with the

formation of a pyonephrosis, or contain blood and result in a hæmato-nephrosis.

Symptoms and Signs. The symptoms closely resemble those of a growth of the renal pelvis, and consist of hæmaturia, renal aching from back pressure, and renal colic from passage of blood clot or fragments of growth down the ureter. The kidney may be enlarged from the resulting hydronephrosis.

Diagnosis. This condition may be extremely difficult to distinguish from a growth of the renal pelvis. Cystoscopy will show blood emerging from one ureteric orifice and sometimes the protrusion of a fragment of growth (see fig. 1573). Intravenous pyelography may show a normal pelvic shadow, though usually a varying degree of distension of the pelvis is observed. A ureteric catheter may be obstructed at the site of the growth, but if it can be passed beyond it, it will drain away clear urine, which becomes blood-stained again when the point of the catheter is withdrawn distal to the growth.

Treatment. This is similar to that for growths of the renal pelvis, and consists of the removal of the kidney, the ureter, and often a small portion of bladder wall surrounding the ureteric orifice. In one case in which nephrectomy only was carried out for a supposed pelvic tumour, bleeding in undiminished quantity continued after operation. Subsequent removal of the ureter revealed a primary papilloma situated half way between the kidney and the bladder, and resulted in a cure.

TUBERCULOSIS OF THE URETER

Tuberculous ureteritis is in all cases secondary to disease of the corresponding kidney, and arises by direct extension from that organ. The earliest change is an elongated narrowing of the lower inch of the ureter, with a slight degree of dilatation immediately above it (see fig. 1560). At this stage the upper ureter, renal pelvis, and calyces show a normal outline and no dilatation from back pressure. Later, thickening of the ureteric wall may cause it to attain the size of a finger and produce irregular contraction of its lumen, or complete obliteration with resulting partial or complete tuberculous hydronephrosis. Both the earlier and the later changes are well shown by intravenous pyelography. On examination there is frequently tenderness along the line of the ureter, which can sometimes be felt

as a thick cord on deep palpation of the abdomen or on rectal or vaginal examination. Changes at the ureteric orifice have already been described under renal tuberculosis.

Treatment. Excision of the ureter at the time of nephrectomy is essential if the degree of ureteritis is at all marked. If this is not done and the ureter is ligatured near the kidney, tuberculous infection of the wound and persistence of secondary tuberculous cystitis is common. Having removed the kidney through the usual lumbar incision, the lower ureter should be exposed extra-peritoneally by an incision made in the mid-line or iliac fossa and ligatured as near the bladder as possible, the stump being cauterised with pure carbolic acid. The ureter, which is still attached to the kidney, is then pulled up and removed through the lumbar incision (see page 2873).

STONE IN THE URETER

Renal stones which pass down the ureter into the bladder without appreciable obstruction are not included under this heading, having been dealt with under "Stone in the kidney." The majority of ureteric calculi are formed in the renal pelvis and become either temporarily or permanently impacted in this tube. In a very few cases the stone has developed primarily in the ureter, having formed round an unabsorbable suture, or in a diverticulum or ureterocele from urinary stagnation. Ureteric stones occur with equal frequency on both sides and are most common in middle life, being rare in children or in old age. Men are affected almost twice as often as women. Smooth stones, composed of uric acid or cystine, are rarely found as they are passed so easily. The two main varieties are calcium oxalate in aseptic urine, and phosphate in infected urine. Some phosphatic calculi have a nucleus of calcium oxalate, suggesting that the infection is secondary to the original stone, but if of phosphatic composition throughout, it is probable that their formation is secondary to a pre-existing infection.

Oxalate calculi tend to be spiculated, and phosphatic stones rough, which accounts for the relative frequency with which impaction occurs at some point in the ureter. They are usually ovoid in shape, but become elongated if present in the ureter for any considerable time.

Oxalate calculi are usually of a lightish brown colour, but tend to become darker according to the length of time they remain in the ureter, this being due to a deposit of blood-pigment on their surface.

Phosphatic calculi are usually greyish-white in colour and have a granular appearance.

In most cases only one stone is present in the ureter, but occasionally multiple calculi occur.

Bilateral ureteric calculi are much less common than bilateral renal calculi, but may give rise to calculous anuria. The commonest sites for impaction are at the pelvi-ureteral junction, at the entrance of the ureter into the bladder, or at a point where the ureter crosses the iliac vessels. Frequently there is a stricture below the point of impaction. The passage of a small stone through the ureter is not usually followed by any definite change in the width of the tube or its walls, though if stones are passed at frequent intervals the lumen of the ureter tends to increase. An impacted stone is liable to cause localised dilatation of the ureter immediately proximal to it, with reddening and congestion of the mucous membrane, which is apt to bleed readily.

If infection is present, there is a great tendency for the renal pelvis and the whole of the ureter proximal to the stone to become markedly dilated. The tighter the impaction, with consequent increase of obstruction to the passage of urine, the more marked is the dilatation. Infection soon spreads outside the wall of the ureter and invades the surrounding tissues, producing peri-ureteral thickening and adhesions.

A stricture distal to a calculus is usually the result of inflammatory changes, though it may sometimes precede and be responsible for its impaction.

Stones impacted in the intra-mural portion of the ureter give rise to a series of changes which can be observed by cystoscopy. A definite bulge is seen above and to the outer side of the ureteric orifice which becomes swollen and surrounded by bullous œdema. The urinary efflux is infrequent, prolonged and forcible.

Occasionally incarceration of a stone may occur in the ureter, due to the giving way of part of the ureteric wall from pressure of the calculus with formation of a false diverticulum which may communicate with the lumen of the ureter by a small orifice, and in which the stone can continue to grow without causing urinary obstruction.

The changes in the kidney due to an impacted ureteric stone consist of dilatation and, later, of superimposed infection, both causing serious damage to the organ. Back pressure will lead to varying degrees of hydronephrosis and eventually complete destruction of the kidney. This emphasises the importance of removing the stone before such damage is irremediable. The more active the kidney, the more severe is the pain from back pressure, and diminution of this pain does not

necessarily suggest an improvement in the condition of the patient, but is rather a sign of increasing renal damage. When infection supervenes, the destruction of renal tissue becomes greatly increased, and the ultimate prognosis will depend on whether the renal infection subsides after removal of the stone or not.

In cases in which the amount of obstruction is insufficient to bring about dilatation of the renal pelvis, some degree of chronic pyelonephritis always occurs, and may gradually bring about fibrosis of the organ. If urinary infection is absent, the opposite kidney usually enlarges from compensatory hypertrophy, but, if present, degenerative changes may occur and the prognosis become extremely grave.

Symptoms and Signs. A small stone passing down the ureter gives rise to a typical attack of renal colic, which has been described under "Renal Calculus." If a stone is passing slowly down the ureter these attacks may vary in intensity and position and have a tendency to be intermittent. The pain is always referred downwards along the course of the ureter, its point of maximum intensity corresponding almost to the position of the stone. While the stone is in the upper ureter, nausea and vomiting are marked, and while in the lower, testicular pain and tenderness are prominent features. A stone in the intra-mural portion of the ureter, especially when projecting into the bladder, is characterised by pain at the end of micturition, which is referred to the tip of the penis. When the stone is impacted, a history can in most cases be obtained of at least one attack of renal colic. If impacted in the upper ureter, pain is usually felt in the costo-renal angle, increased by exercise or the taking of diuretics, and relieved by rest. If impacted at a slightly lower level, pain is felt in front, just external to the rectus muscle in the region of the tip of the ninth rib. With lower levels of the stone, the pain may be situated anywhere along a line extending from the outer border of the rectus muscle to the external abdominal ring. If impacted in the intra-mural part of the ureter, genital symptoms may occur, such as pain referred to the testicle or to the labium majus and, in addition, pain on coitus during ejaculation, pain from nocturnal emissions, and sometimes the presence of blood in the semen. Occasionally there is pain in the rectum, aggravated by defæcation. Frequency and terminal dysuria referred to the tip of the penis are common.

In the absence of infection, some degree of hæmaturia is usually present. This may vary from a few blood cells to large quantities of macroscopic blood. In addition, epithelial cells of ureteric origin are

present and often a few pus cells, even though organisms are absent. Hyaline casts indicate some degree of renal involvement. Crystals are frequently seen, but have little diagnostic value. When secondary infection occurs, organisms and pus cells are of course present.

Symptoms of renal back pressure are common, and are characterised by a dull aching pain in the loin, usually in the posterior renal angle, together with tenderness on palpation. Muscular rigidity may be present if the pain is severe. In aseptic cases the kidney is rarely palpable. If secondary infection has occurred, fever and general constitutional symptoms are superadded, and sometimes a tumour due to a pyonephrosis can be felt in the loin. The most important symptoms of back pressure are persistent renal aching and tenderness, which, if present, should be regarded as an indication for early operation.

Diagnosis. Routine examination of the genital tract will, in many cases, reveal some focus of infection, such as chronic prostatitis or cervicitis, and as this may constitute an aetiological factor in the formation of the renal stone, its significance should not be overlooked.

The lower urinary tract may be the seat of obstruction due to either a stricture or an enlarged prostate. In a few cases, on rectal or vaginal examination, a calculus may be felt in the lower part of the ureter. In only the rarest of cases can a stone be felt abdominally in the upper part of the ureter. There may be tenderness over the ureter and kidney and some degree of muscular rigidity. Examination of the urine may reveal the characteristics already described, but abnormal constituents are less often observed than in cases of renal calculus.

Cystoscopic appearances. Cystoscopy may or may not show some evidence of a ureteric stone. As a rule some definite change can be recognised which may be either an alteration in the appearance of the orifice or a change in character of the efflux.

(1) Appearance of ureteric orifice. The earliest change is some swelling of the lips and some rigidity of the orifice which may become patulous. The lower the stone, the more marked does the swelling become and the greater is its tendency to involve the trigone and inter-ureteric bar in its immediate vicinity. A stone in the intra-mural part of the ureter gives rise to bullous oedema which may entirely obscure the opening, though in some cases the edge of the stone may be actually seen to project into the bladder (fig. 1597). Ulceration, if present, illustrates the natural way by which a ureteric stone passes into the bladder (fig. 1598). In the early stages of its descent minute

multiple hæmorrhages are often observed around the meatus, chiefly over the intra-mural part of the ureter (fig. 1599). In the later stages, when the stone is near the orifice, these hæmorrhages become more marked and may give rise to bleeding at the end of micturition, as contraction of the bladder occurs.

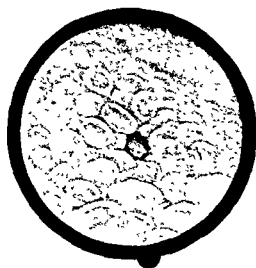


Fig. 1597.—STONE PROJECTING FROM URETERIC ORIFICE SURROUNDED BY BULLOUS EDEMA.

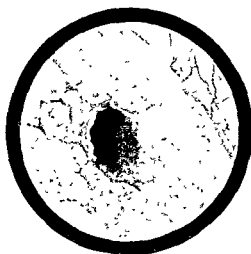


Fig. 1598.—RIGHT URETERIC ORIFICE AND SURROUNDING BULLOUS EDEMA IMMEDIATELY AFTER THE PASSAGE OF A URETERIC CALCULUS.



Fig. 1599.—PUNCTATE HÆMORRHAGES ABOVE RIGHT URETERIC ORIFICE, DUE TO A STONE BECOMING IMPACTED IN THE INTRA-MURAL PART OF THE URETER.

(2) Character of efflux. The frequency of the efflux varies and may be increased or decreased. An increase is common in the presence of a recently impacted stone, and a decrease in later stages, especially when some degree of dilatation of the kidney has occurred. The amount of urine at each efflux is usually diminished and this is best shown after

intravenous injection of indigo-carmin. With complete obstruction the efflux will be absent. It may be clear or blood-stained, according to the amount of damage caused to the wall of the ureter by the calculus. Infection is shown by cloudiness.

Ureteric Catheterisation. A ureteric catheter will in most cases be obstructed at the site of the impacted stone, but if of small size, and if movements of introduction and withdrawal be combined with rotation, it is often possible to make it pass the stone and reach the kidney. Strong and frequent ureteric effluxes will suggest that this may be successful, but a weak infrequent efflux usually indicates that there will be difficulty or complete arrest in its passage. Catheterisation will enable an ascending pyelogram to be carried out, and will allow the functional value of the kidney to be determined. If the kidney is hydronephrotic, urine will drain from the catheter in a continuous flow under pressure, and thereby invariably relieve the pain of renal colic, as has already been described.

Radiography. An X-ray photograph usually reveals a shadow in the line of one ureter (fig. 1600), and should be followed by the passage of an opaque catheter or bougie which will determine the exact situation of the ureter and its relationship to the shadow of the calculus (see fig. 1530). This is rendered even more positive by making a double shift exposure which should show no alteration in the relation of the stone to the opaque catheter. Exact information as to the degree of distension of the renal pelvis can be obtained by ascending pyelography.

Intravenous pyelography is an alternative method of diagnosis, but difficulties arise if, owing to damage of the kidney, there is a poor secretion of the opaque medium. In most cases, however, a good shadow of the pelvis and ureter can be obtained and the suspected shadow be proved to be that of a calculus impacted in the ureter (see fig. 1565). A uric acid stone, however, is non-opaque and the diagnosis must be made by other means. Indirect evidence of its presence is shown by nodular dilatation of the ureter at the site of impaction (fig. 1601). Some resemblance to ureteric stones is caused by the shadows of calcified mesenteric glands, intestinal contents, and phleboliths in the pelvic veins. Pyelography and the fact that they are usually multiple will prove them to be extra-mural.

Functional Value of the Kidney. The functional value of the kidney is best assessed by the intravenous injection of indigo-carmin or the

urea split function test after catheters have been passed up both ureters. Fifteen grammes of urea dissolved in 100 cc. of water are given by mouth one and a half hours previously. A few cc. of urine are collected from each side and the percentage of urea estimated in each specimen.



Fig. 1600.—LEFT URETERIC CALCULUS. PLAIN X-RAY. THE INTRAVENOUS PYELOGRAM OF THIS CASE IS SHOWN IN FIG. 1543.



Fig. 1601—RIGHT ASCENDING PYELOGRAM SHOWING NODULAR DILATATION OF THE LOWER END OF THE URETER PROXIMAL TO A URIC ACID CALCULUS WHICH FAILS TO THROW A SHADOW.

Differential Diagnosis. Renal colic, with its intense pain, if accompanied by abdominal distension, absolute constipation and muscular rigidity, may be exceedingly difficult to distinguish from an abdominal emergency. Examination of the urine, the tenderness in the post-renal area, and the localised rigidity of the abdominal wall are all in favour of renal colic. A rapidly increasing pulse, or pulse-rate over 100 is suggestive of an intra-peritoneal lesion. An impacted stone associated with vomiting, constipation, fever, and tenderness in the right iliac fossa, may simulate appendicitis.

Treatment. A ureteric calculus may be treated expectantly, by cystoscopic manipulation, or by open operation. Five factors must be considered before arriving at a definite decision: (1) The size of the stone, (2) the position of the stone, (3) the length of time it has been impacted, (4) the condition of the kidney, and (5) the tolerance of the patient and the experience and instrumental skill of the surgeon.

(1) Size of the stone. As a rule, small stones should be treated expectantly, though if rough or spiculated, they may pass with more difficulty than a large smooth stone.

(2) Position of the stone. A stone impacted in the upper part of the ureter and showing no signs of descending should usually be treated by operative measures if an attempt by cystoscopic methods has failed. Stones in the lower part of the ureter are ideal for cystoscopic removal, and this should be considered the method of choice, as it is successful in three-quarters of the cases.

(3) Duration of impaction. The longer the impaction, the greater is the likelihood of peri-ureteral thickening and stricture formation, though instrumental dilatation may be sufficient to overcome the latter. If lying in a diverticulum operative removal is essential. Two months should be regarded as the maximum period for which a stone may be allowed to remain impacted, at the end of which time it should be removed surgically.

(4) Condition of the kidney. If the renal function is good, as indicated by continued attacks of severe pain and the presence of only a small degree of hydronephrosis, as shown by pyelography, a stone can be treated expectantly or instrumentally. If, however, signs of renal involvement supervene, such as diminishing pain or increasing hydronephrosis, these methods must be abandoned in favour of ureterolithotomy in order to preserve the functional capacity of the organ. If the condition of the kidney is beyond recovery, and the opposite one is healthy, it is advisable to carry out a nephro-ureterectomy, the ureter being ligatured below the site of impaction.

(5) Tolerance of the patient. Patients vary greatly in their degree of tolerance to cystoscopic manipulation, though this can be greatly increased by efficient anæsthesia and manipulative experience of the surgeon.

Expectant Treatment. This is justifiable in patients who have previously passed stones and in whom the calculus in question is not

more than 10 mm. in diameter and has only recently become impacted. Contra-indications include : (1) Evidence of renal back pressure, such as dilatation of the kidney and diminution in severity of the attacks of renal colic ; (2) lower urinary obstruction, such as urethral stricture or enlarged prostate ; (3) medical disease of the kidney, such as chronic parenchymatous nephritis, which contra-indicates the taking of large quantities of fluids ; and (4) the presence of infection.

The treatment consists of taking large quantities of fluids, such as Vittel, Contrexéville, or barley water, together with diuretics such as potassium citrate. If followed by a rise in temperature or an increase in renal pain, which indicates ureteric obstruction, this method should be discontinued.

Papaverine administered subcutaneously has been found of value, and hexamine before meals, followed by an acid mixture after, is of use if infection is present.

The position of the calculus should be checked by serial X-rays, and if no appreciable descent is observed within four weeks, this treatment should be abandoned.

Instrumental Treatment. A ureteric catheter, if it can be passed above the stone, will immediately relieve the pain of renal colic by decompressing the pelvis. It is, however, a purely palliative procedure, as it diminishes the urinary pressure which is the main factor propelling the stone downwards. Omnopon $\frac{2}{3}$ gr. and scopolamine $\frac{1}{150}$ gr. should precede this treatment.

Sometimes the simple passage of a catheter is enough to dislodge the stone, and to bring on an attack of renal colic which causes it to descend to a lower level.

Stone Impacted in the Upper End of the Ureter. Two procedures are available for assisting the downward migration of a stone in the upper ureter : dilatation of the ureter, and injection of drugs into it. These procedures are usually combined.

(A) *Dilatation of the Ureter.*

(1) The ureter can be dilated by the passage of ureteric catheters or bougies. These may be passed in increasing sizes up the ureter in order to secure an adequate expansion for the subsequent passage of the calculus. In favourable cases it is possible to pass one proximal to the stone, which will dilate an associated stricture and tend to

left tied in for a few days; following its removal the stone will frequently pass naturally, though there is generally some obstruction at the ureteric orifice.

(2) The ureter may be dilated with Buerger's dilating olives, which may be used alone or activated by diathermic heat which is said to diminish spasm. Metal olive-shaped heads of different sizes are screwed on to an insulated flexible electrode (fig. 1602). A small-sized olive is selected and passed up the ureter until it reaches the stone, when a weak current is turned on for a few seconds. The instrument is then removed, the olive replaced by a larger one, and the procedure repeated.

(3) A small four-bladed dilator, working on the principle of a Kollmann urethral dilator, is passed up the ureter and each section dilated in turn by rotating a milled head which controls the movement of the blades (fig. 1603).

(4) Swift Joly has designed a ureteric catheter with a thick-walled rubber bulb attached to its distal end (fig. 1604). The bulb is expanded by injecting water into it through the ureteric catheter by means of a syringe. It has the advantage of inflicting far less damage on the ureteric wall than the four-bladed dilator.

(B) *Injection of Drugs.* Three types of drug have been found to be of great value; all are injected through a ureteric catheter which is passed, if possible, proximal to the stone.

(1) *Lubricants.* The best of these is olive oil, of which not more than 5 cc. is used.

(2) *Anti-spasmodics and anæsthetics.* Five per cent papaverine or a mixture of 2 per cent cocaine and sodium bicarbonate in distilled water will be found to be the most effective. A lubricant and an anti-spasmodic may be combined, a mixture of 5 per cent papaverine in 5 cc. of olive oil being commonly employed.

(3) *Antiseptics for irrigation of the renal pelvis and mechanical mobilisation of the stone.* Under this heading are included acriflavine 1 in 2000, oxycyanide of mercury 1 in 4000, and silver nitrate 1 in 4000.

Cystoscopic instrumentation, when applied to a calculus in the upper part of the ureter, is most likely to succeed in the case of a small, recently impacted stone, but no definite rule can be laid down, as good results have been obtained in apparently impossible cases.

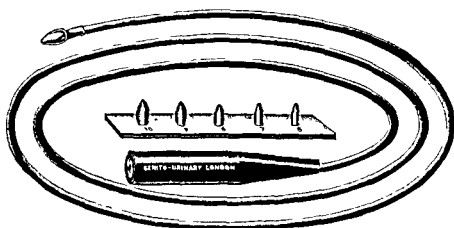


Fig. 1602.—BEERGER'S OLIVES AND GUIDE.



Fig. 1603.—GENITO-URINARY MFG. COMPANY'S FOUR-BLADED URETERIC DILATOR.

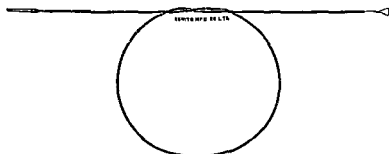


Fig. 1604.—SWIFT JOLY'S HYDROSTATIC URETERIC CATHETER.

Stone Impacted in the Lower End of the Ureter. A stone in the lower end of the ureter, and especially if impacted in its intra-mural part, is eminently suitable for cystoscopic methods. Dilatation of the ureter and injection of drugs are both of the utmost value, but in this situation certain additional methods are applicable. The ureteric orifice is the narrowest part of the whole tube, and in most cases will require enlarging to liberate the stone situated just above it, or as a preliminary to instrumental procedures on its upper part.

(1) *Cystoscopic Scissors.* These consist of a long flexible stem, which can be passed through an operating cystoscope, carrying at their distal extremity a fine pair of scissors, one blade of which is probe-pointed and the other sharp. The blades are controlled by handles attached to the proximal end of the stem. The probe point is introduced into the ureteric orifice and one or more snips are made in an upward and outward direction in the line of the ureter (see fig. 1591). Hæmorrhage is rarely troublesome, but if marked can be readily checked by means of a diathermy terminal applied to the bleeding point, the current being turned on for a few seconds.

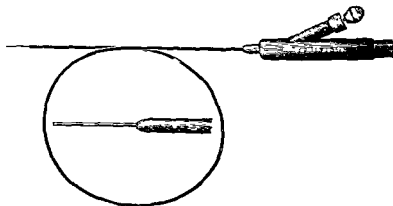


Fig 1605.—URETERIC MEATOMY FOR SLITTING URETERIC ORIFICE.

(2) *Diathermy.* (a) *Coagulating current.* A ureteric catheter is passed through a double catheterising cystoscope into the ureteric orifice, and a diathermy electrode through the other channel. The catheter defines the position of the tube, which is seared on its vesical aspect by the diathermy electrode. The coagulated area thus produced will slough away in a week, but it is often of great value to slit it up with cystoscopic scissors immediately after the application of diathermy. Bleeding in this case does not occur and a large ureteric orifice results.

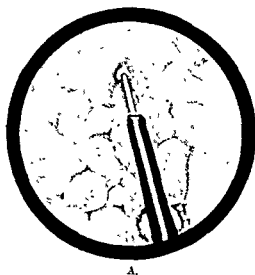


Fig. 1606.—URETERIC MEATOTOMY FOR A STONE IMPACTED AT AND PROJECTING FROM THE RIGHT URETERIC ORIFICE. A. CYSTOSCOPIC VIEW. B. SECTIONAL VIEW.

(b) *Cutting current.* As in the foregoing method, a ureteric catheter is passed into the ureter. A ureteric meatotome (fig. 1605), which consists of a fine wire, insulated except for a small part of its distal extremity, is passed through the other channel. The ureter is then slit up by making a series of stroking cuts until the catheter is exposed. Bleeding is automatically arrested by the current. In some cases when marked bullous oedema is present and the stone is either at or projecting from the orifice, it may be impossible to pass a ureteric catheter, in which case the wire electrode is used alone and the tissues divided until the stone is fully exposed (fig. 1606), great care being taken to prevent too deep a cut which

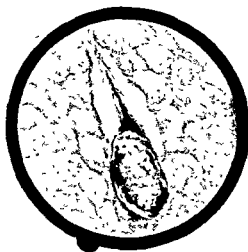


Fig. 1607.—STONE EMERGING FROM RIGHT URETERIC ORIFICE AFTER URETERIC MEATOTOMY.



Fig. 1608.—RIGHT URETERIC ORIFICE, WITH SURROUNDING BULLOUS OEDEMA AFTER URETERIC MEATOTOMY FOR LIBERATION OF A URETERIC CALCULUS.

may penetrate the posterior wall of the ureter. If the orifice is watched after ureteric meatotomy, it is frequently possible to see the stone "born" (fig. 1607).

If, following enlargement of the orifice, the stone is not visible (fig. 1608), treatment by dilatation and injection is carried out.

In some cases it is justifiable to pass a ureteric probang which should be entirely composed of gum elastic (fig. 1609). Metal varieties have been used but are not to be recommended owing to the excessive damage they may cause to the ureteric wall during their passage. The probang is only of service if it can be passed proximally to the stone. It is then opened and an attempt made to pull the stone downwards to a lower level.

Cystoscopic methods for extracting a stone may be continued at intervals, provided the condition of the kidney is satisfactory as shown by periodic pyelography, etc., but any deterioration of the organ is an indication for operative treatment.



Fig. 1609.—GUM ELASTIC URETERIC PROBANG.

Contra-indications to instrumentation include severe reaction to treatment, as shown by repeated rigors or sudden rises of temperature. An attack of renal colic following ureteral instrumentation should be regarded as a good sign, proving the presence of an active kidney, and not as a contra-indication to further treatment.

Instrumental treatment should always be combined with the administration of diuretics, as described under "Expectant Treatment."

Operative Treatment. This is indicated (1) when medical and instrumental treatment are contra-indicated; (2) when dilatation of the kidney is commencing; (3) when infection has occurred, and (4) in calculous anuria.

Operative treatment entails not only the removal of the stone, but also the cure of the disease to which it owes its origin. In aseptic urine the former may be all that is necessary, though a careful search must be made for an ætiological cause, such as chronic prostatitis, chronic cervicitis, and upper or lower urinary tract obstruction, which is dealt with either at the same time or reasonably soon afterwards.

The kidney may be the seat of further stones, of hydronephrosis,

or pyonephrosis, or may be almost completely destroyed by atrophy, and careful investigation is necessary to determine whether the organ will recover after the removal of the calculus. Too much importance should not be attached to a depression of the renal function, as this often rapidly improves after the removal of its cause. Evidence of renal destruction, as shown by pyelography and ureteric catheterisation, is of greater importance. Two general principles should be borne in mind : If it is thought that the kidney will recover, the ureteric stone should first be removed before any operative interference with the kidney is carried out. If it will not recover, e.g. in the presence of pyonephrosis, calculous pyonephrosis, or advanced hydronephrosis, the organ should be removed, provided the opposite kidney is healthy, and the ureteric calculus dealt with secondarily, either at the same time if the patient's condition is satisfactory, or at a later date.

A stone impacted in the upper ureter is exposed by the ordinary kidney incision ; if at the brim of the pelvis, by an incision extending from the anterior superior iliac spine downwards and inwards, parallel to Poupart's ligament and 2 inches above it. A calculus in the lower end of the ureter may be removed through a similar incision or a paramedian one. In some cases of stone in the intra-mural part of the ureter, which cannot be dislodged by cystoscopic manipulation, it may be necessary to remove it by suprapubic cystotomy, combined with extra-peritoneal exposure of the lower end of the ureter.

OPERATIONS ON THE URETER

- (1) Extra-peritoneal exposure of the upper end of the ureter.
- (2) Extra-peritoneal exposure of the lower end of the ureter.
(a) Lumbar route. (b) Iliac route.
- (3) Nephro-ureterectomy.
- (4) Uretero-lithotomy.
- (5) Uretero-ureteral anastomosis.
- (6) Uretero-vesical anastomosis.
- (7) Uretero-intestinal anastomosis.

(1) *Extra-peritoneal Exposure of the Upper End of the Ureter.* The preparation of the patient, the anæsthetic, the position, and the preliminary steps of the operation are identical with the exposure of the kidney by the lumbar route (see page 2821).

The upper part of the ureter lies behind the ascending colon and cæcum on the right side and the descending colon and sigmoid flexure of the colon on the left. By retracting the peritoneum and large bowel it will be found that the ureter is not adherent to either of these structures, and is readily recognised when tension is made on it by pulling the kidney upwards. By means of gauze stroking it is easily isolated from the surrounding fatty areolar tissue and can be brought readily into the wound. Further procedures will depend on the object of the operation. The wound is closed with drainage, as described on page 2824.

(2) *Extra-peritoneal Exposure of the Lower End of the Ureter* (fig. 1610). The lower end of the ureter can be exposed, either by a *median* or an *iliac* incision. The preparation of the patient and the anæsthetic are the same as for exposure of the kidney.

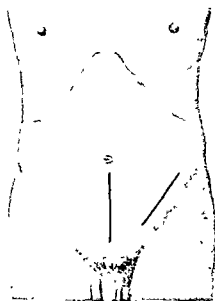


Fig. 1610.—EXPOSURE OF LOWER END OF URETER;
MEDIAN AND ILIAC INCISIONS.

The patient is placed in the dorsal position and shoulder pieces are arranged for the subsequent adoption of the Trendelenburg position. The skin is painted with 3 per cent picric acid in spirit, and mackintoshes and towels are adjusted.

Median route. The incision runs vertically downwards from a point just below the umbilicus to the symphysis pubis; the skin and subcutaneous tissues are cut through and any bleeding points ligatured. The anterior rectus sheath is incised, the interval between the recti

muscles sought for, and the muscles separated for the full length of the wound.

The patient is placed in the Trendelenburg position and the peritoneum is stripped up with gauze stroking from the anterior and lateral aspects of the bladder. Self-retaining retractors are inserted into the wound and the stripping of the peritoneum from the lateral wall of the bladder and from the iliac fossa is continued until the external iliac vessels and the lower end of the ureter are exposed. The latter will, as a rule, be found to adhere to the peritoneum and may be retracted and overlooked. If difficulty is experienced in locating the ureter, it should be remembered that it crosses the bifurcation of the common iliac vessels and the tip of the spine of the ischium, and that close to its junction with the bladder the *vas deferens* will be seen hooking round it on its way from the internal abdominal ring to its junction with the seminal vesicle at the upper margin of the prostate. Once the ureter is isolated it is brought up into the wound by surrounding it with a piece of gauze, further proceedings depending on the object of the operation. When these have been carried out, a drainage-tube $\frac{1}{2}$ inch in diameter is inserted down to the ureter and brought out at the lower end of the wound. The self-retaining retractors are removed, the recti muscles allowed to fall together, and the anterior rectus sheath approximated with a continuous suture of No. 2 chromicised catgut. The skin is united with interrupted fishing-gut eversion stitches of which one is passed through the drainage-tube. The wound is painted with picric acid and dressings are applied.

Iliac route. A curved incision is made from a point one inch internal to the anterior superior iliac spine running downwards and inwards to a point one inch above the middle of Poupart's ligament. The skin, subcutaneous tissues, external oblique, internal oblique, and transversalis muscles are divided for the full extent of the wound.

The patient is placed in the Trendelenburg position and the peritoneum is stripped off the outer and posterior wall of the pelvis until the external iliac vessels are exposed. Self-retaining retractors are inserted and a search is made for the ureter, either where it crosses the common iliac vessels or the spine of the ischium, or on the outer aspect of the peritoneum to which it is frequently adherent. When identified, it is gently isolated from the extra-peritoneal fat and rendered prominent by surrounding it with a strip of gauze. Further procedures depend on the object of the operation, which is completed by inserting a drainage-tube $\frac{1}{2}$ inch in diameter down to the ureter and bringing it

out at the lower and inner end of the wound. The self-retaining retractors are removed and the muscles united as accurately as possible by interrupted sutures of No. 2 chromicised cutgut. The skin is approximated by interrupted fishing-gut eversion sutures one of which is passed through the drainage-tube. The wound is painted with picric acid and dressings are applied.

Of the two incisions the median affords a far better approach, giving access to a greater length of ureter than the iliac incision. No abdominal muscle is cut or injured during the operation, and the subsequent scar tends to be firmer and more satisfactory in every way.

Complications. Difficulty in finding the ureter has already been mentioned. Previous inflammation, such as a past attack of appendicitis, operation such as hysterectomy, or injury such as a uretero-vaginal fistula, are each followed by dense adhesions which increase the difficulty of isolating the ureter, and often make it impossible to do so without opening the peritoneal cavity. In some cases a small portion of the peritoneum attached to the ureter must be deliberately excised and the resulting gap sutured.

Inflammatory diseases of the ureter, such as tuberculous ureteritis, may cause such thickening of the tube that it resembles a piece of small intestine. This increase in size may in itself lead to confusion unless its significance is realised.

Hæmorrhage is, in some cases, marked, but good retraction and illumination, preferably with a headlight, and immediate ligature of any bleeding vessels will help to make this complication less formidable.

(3) *Nephro-ureterectomy. Indications.* (a) Villous carcinoma of the renal pelvis. (b) Some cases of renal tuberculosis in which much ureteritis is present.

The preparation of the patient, the anæsthetic, the position and the preliminary steps of the operation are the same as for nephrectomy (see page 2819), which is carried out, however, without clamping or ligaturing the ureter. Tension is made on the kidney, and the ureter freed as far as possible from its surroundings by the fingers of one hand, which follow it deeply into the pelvis. A drainage-tube is inserted down to the region of the cut pedicle, the kidney is withdrawn from the wound, and the latter closed in layers. The kidney, still attached to the ureter, is surrounded with a large gauze swab, the wound is painted with picric acid, and dressings are applied (fig. 1611). The patient is rolled

over into the dorsal position, the lower part of the abdomen is painted with picric acid, and mackintoshes and towels are adjusted. The lower end of the ureter is exposed through a median or iliac incision, and is readily found by making traction on the kidney which puts it on the stretch. After isolating the tube as near its opening into the bladder as possible, two pairs of long Spencer Wells forceps are applied to it and a strip of gauze placed around it. The ureter is divided between the clamps and each end carefully painted with pure carbolic acid

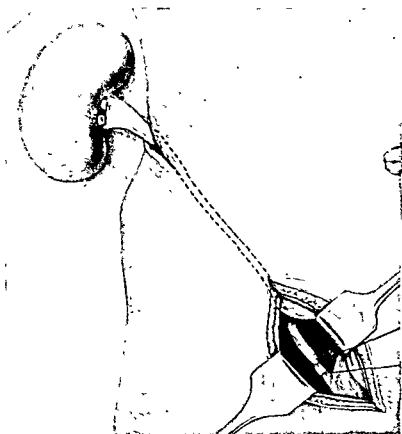


Fig. 1611.—NEPHRO URETERECTOMY; KIDNEY OUTSIDE LUMBAR INCISION. URETER EXPOSED AND ABOUT TO BE DIVIDED BETWEEN LIGATURES.

(fig. 1611). Ligatures are applied to the cut ends and the forceps removed. By pulling on the kidney the whole of the ureter is withdrawn through a gap between the stitches of the lumbar incision. If oozing has occurred, a small drainage-tube is inserted to the site of the lower end of the ureter and the wound closed in layers.

(4) *Uretero-lithotomy. Indications.* Removal of an impacted stone, after instrumental procedures have failed to dislodge it.

The ureter is exposed, as described on page 2869, in its upper or

lower part according to the position of the stone as determined by preliminary investigations. Palpation, as a rule, reveals the presence of the calculus. and the particular section of the tube involved is isolated by passing a strip of gauze behind it. A gentle attempt is made to squeeze the calculus into a higher segment of the tube; it is then removed through a small vertical incision by means of stone forceps, care being taken to prevent fragmentation. If the stone cannot be moved the incision should be made directly over it. The object of incising the ureter at a level above the site of impaction is to prevent subsequent stricture formation, which is less liable to occur when comparatively healthy tissues are cut across. After removal of the calculus a large ureteric catheter or bougie is passed gently downwards in order to exclude the presence of a stricture or to dilate up the lumen of the canal if contraction has occurred. Two or three fine catgut sutures are inserted in the outer wall of the ureter to bring the edges of the incision together. A drainage-tube $\frac{1}{2}$ inch in diameter is passed down to the suture line and the wound closed in layers, one skin stitch being passed through the tube.

(5) *Uretero-ureteral Anastomosis. Indications.* (a) Accidental division of the ureter during hysterectomy. (b) Deliberate section when involved in scar tissue, often the result of its inclusion in a ligature.

An adequate length of tube is essential, otherwise uretero-vesical anastomosis should be considered.

The chief post-operative complication is stricture formation, and this should be anticipated as far as possible by the type of operation performed, the previous sterilisation of the urinary tract, and the provision for extra-peritoneal drainage to the site of anastomosis. Further, a union should be carried out which will allow the subsequent passage of ureteric bougies, which constitutes an important step in the after-treatment.

The best operation to fulfil these requirements is end-to-end oblique anastomosis.

End-to-end Oblique Anastomosis (fig. 1612). After placing the patient in the Trendelenburg position, the ureter is exposed extra-peritoneally by an iliac or median incision. The site of injury or obstruction is found, and a small section of the tube is excised. The upper and lower ends of the ureter are then cut obliquely and united by interrupted sutures of fine plain catgut over a ureteric catheter, passed at the

beginning of the operation. In order to minimise the risk of subsequent stone formation these sutures do not pass into the lumen of the tube. The oblique union to some extent prevents narrowing at the site of anastomosis.

A drainage-tube is passed to the point of union and the wound closed in the usual manner. The ureteric catheter is removed after three days.

Post-operative treatment consists of the intermittent passage of ureteric bougies and a periodic intravenous pyelogram to assess the degree, if any, of resulting hydro-ureter or hydronephrosis.

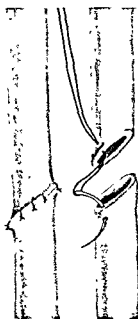


Fig. 1612.—URETERO-URETERAL ANASTOMOSIS.

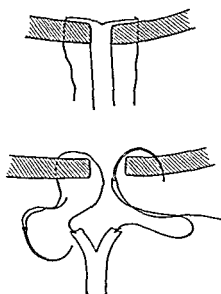


Fig. 1613.—URETERO VESICAL ANASTOMOSIS.

(6) *Uretero-vesical Anastomosis. Indications.* (a) A malignant vesical growth involving one ureteric orifice. (b) Injury or ligature of the ureter during a gynæcological operation, followed by a uretero-vaginal fistula.

The preparation of the patient and the anæsthetic are the same as for exposure of the kidney. The patient is placed in the dorsal position and shoulder pieces are arranged for the subsequent adoption of the Trendelenburg position. The skin and external genitals are painted with 3 per cent picric acid in spirit, a catheter is passed into the bladder, the viscus washed out and distended with boric lotion, and a sigmoid inserted. Mackintoshes and towels are adjusted.

Operation. The lower end of the ureter and bladder are exposed by a median suprapubic incision. The ureter is traced downwards until the seat of obstruction is found. At this point the ureter will be seen to pass into a mass of fibrous tissue, usually the result of a ligature near the lateral margin of the vaginal vault. The ureter is divided as near the obstruction as possible, freed from its surroundings for about 2 inches, and its distal end split for about $\frac{1}{2}$ an inch. A catgut stitch, threaded on a fully-curved round-bodied needle, is passed through one edge of the ureter and tied, and another is passed through the other edge. Both are laid on one side. The subsequent steps depend upon whether the bladder is opened suprapubically or not.

(a) *Bladder not opened suprapubically.* A small puncture is made through the entire thickness of the bladder wall of a size equal to the ureter, which is often dilated, and as near it as possible, and the bladder allowed almost to empty itself by withdrawing the spigot from the catheter.

One of the curved needles threaded with catgut, which is attached to the split edge of the ureter, is passed through the puncture and out through the bladder wall $\frac{1}{2}$ inch away from it (fig. 1613). The other needle is also passed through the puncture and out through the bladder wall on the opposite side to the first needle. The two ends of catgut are tied together, after making quite certain that there is no tension or kinking of the ureter, and the wound is closed in the usual way after passing a drainage-tube down to the site of anastomosis. The catheter in the bladder is tied in and allowed to remain for four days, after which it is removed and a similar one tied in for a like period.

The drainage-tube is shortened after four days and removed in seven.

(b) *Bladder opened suprapubically.* The bladder is opened by a vertical incision between traction sutures, after allowing it to empty itself by removing the spigot from the catheter, and a puncture is made through its wall at a point as near the ureter as possible and equal to it in size. The split ends of the ureter are passed through the puncture and each end is stitched to one lip of the small wound. A Winsbury-White suprapubic catheter is sewn into the bladder and retained for ten days. A small tube is passed down to the ureter as it enters the bladder, is shortened in four days and removed in seven.

(7) *Uretero-intestinal Anastomosis. Indications.* (a) In some cases of injury to the ureter in which other types of anastomosis are impossible. (b) In some cases of ectopia vesicæ. (c) As a preliminary to cystectomy. (d) In some cases of severe vesico-vaginal fistula.

Winsbury-White's Operation. Two important principles are involved in this method. Firstly, a barrier is provided against the ascent of infection from the bowel to the kidney, and secondly, the implantation is brought about without any danger to the vitality of that portion of the ureter immediately in relation to the bowel at the site of the anastomosis. All the evidence points to the fact that infection ascending to the kidney passes upwards not by way of the lumen of the ureter but in some deeper plane. By establishing firm union between the bowel and the ureter before the element of sepsis is introduced into the field of operation by opening the bowel, a protective fibrous tissue barrier is formed which should act as a safeguard against renal infection. The vitality of the ureter is assured by the fact that the portion of this structure which is disturbed from its bed continues to receive its blood supply both from above and below.

The procedure is performed in two stages. In the first, the ureters are dislodged from their beds in the iliac region and are grafted into the wall of the pelvic colon. Firm union is allowed to occur before the lumen of either ureter is divided or opened and without interrupting the flow of urine along the ureters into the bladder. In the second, the ureters, now firmly attached to the bowel, are drained into the lumen of the latter structure. The details of the technique can be followed by referring to the illustrations.

Operation. The abdomen is opened and the portion of the pelvic colon which lies just above the promontory of the sacrum is chosen for the site of the anastomosis. An incision 3 inches in length is made through the peritoneum in the line of the left ureter at the level of the site chosen for the implantation. The exposed portion of this structure is then gently dissected from its bed and the peritoneum re-sutured behind it. An incision $\frac{1}{2}$ inch in length is now made along the left lateral margin of the portion of the pelvic colon which has been selected, passing through its peritoneal and muscular coats. The muscular wall is separated freely from the mucosa along each margin of the incision, sufficiently to allow the cut edges to be re-sutured over the ureter without tension. This procedure is carried out with a continuous catgut suture (fig. 1614).

A fortnight later the abdomen is again opened and the left ureter is divided between clamps about $\frac{3}{4}$ inch below the distal limit of its union with the bowel. The proximal portion of the divided

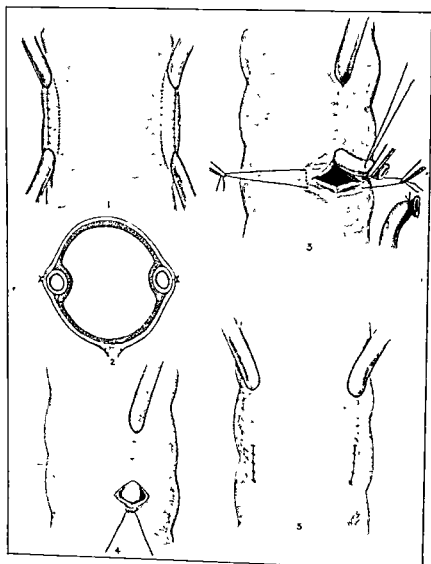


Fig. 1614.—(1) THE URETERS IMPLANTED INTO THE BEDS MADE FOR THEM IN THE WALL OF THE PELVIC COLON. (2) A TRANSVERSE SECTION OF THE BOWEL AT THE SITE OF THE GRAFTS. (3) THE DIVISION OF THE GRAFTED URETER AND THE INSERTION OF ITS CUT END INTO THE LUMEN OF THE BOWEL. (4) THE FIXATION OF THE OPEN END OF THE DIVIDED URETER WITHIN THE LUMEN OF THE BOWEL. (5) THE FINAL APPEARANCE AFTER BOTH URETERS HAVE BEEN DRAINED INTO THE BOWEL.

(Winsbury White, "Proc. Roy. Soc. Med.")

ureter is transfixed by a catgut suture and the other portion is ligated. Two traction sutures are then placed through the bowel wall on either side of a line along which a longitudinal incision will be made to open into the lumen for $\frac{1}{2}$ inch. This cut must divide the wall of the

intestine right up to the lower surface of the ureter where these two structures are adherent. The two ends of the suture which previously transfixed the upper end of the divided ureter are now threaded through a small curved round-bodied needle. The clamped end of the ureter is next severed from the main structure and the lower border of the open duct is divided in its long axis for $\frac{1}{4}$ inch.



Fig. 1615.—INTRAVENOUS PYELOGRAM, AFTER IMPLANTATION OF BOTH URETERS INTO THE PELVIC COLON.

The open end of the ureter is fixed within the lumen of the bowel by passing each needle in turn through the opening in the latter and transfixing the wall from within outwards below the lower limit of the cut. The suture ends are tied.

The hole in the bowel wall is then closed by a continuous through-and-through catgut suture which is reinforced by a line of Lembert sutures. The abdomen is closed with a rubber drain passing down to the site of the anastomosis.

In bilateral anastomosis the same procedure is repeated on the opposite side at the same operation.

Figure 1615 depicts an intravenous pyelogram taken several weeks after bilateral implantation, and shows good functional activity of the kidneys with slight ureteral dilatation on both sides.

CHAPTER IV

DISEASES OF THE BLADDER

CONGENITAL DEFORMITIES

Ectopia Vesicæ (fig. 1616). This rare condition is characterised by a congenital absence of the anterior wall of the bladder, together with a failure of union of the lower part of the anterior abdominal wall across the mid-line, with the result that the vesical mucous

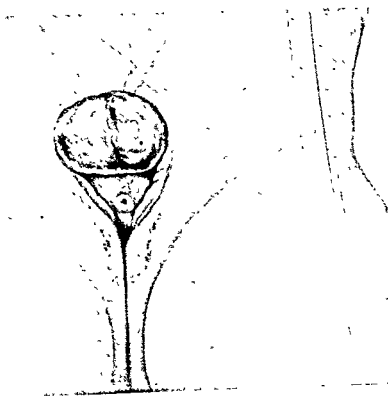


Fig. 1616.—ECTOPIA VESICÆ.

membrane is exposed to the surface with continuous discharge of urine. The mucous membrane has a dull red velvety appearance, the ureteric orifices are clearly visible, and the characteristic effluxes are seen to emerge from them.

The trigone is undeveloped, the surrounding skin is inflamed and

excoriated, and the pubic arch may be deficient and separated in the mid-line by a distance of two or three inches.

Other deformities, such as hare-lip, cleft palate, or spina bifida are also sometimes present.

The deformity may occur in either sex. In the male the penis is rudimentary, and the urethra is represented by a groove on its dorsal aspect—epispadias. The scrotum is split and the testicles are usually retained within the abdomen. The prostate also is rudimentary. Subjects thus afflicted rarely attain adult life, as ascending pyelonephritis is a common sequel.

Treatment. This should be operative if the renal function tests are satisfactory. The best procedure consists of transplantation of the ureters into the large bowel by the two-stage method of Winsbury-White (see page 2877), though some urologists still prefer to transplant an oval portion of the bladder base, containing the two ureters, into the pelvic colon by Maydl's method. The remainder of the bladder is excised. An attempt is then made to close the gap in the abdominal walls by mobilising the recti muscles and overlying skin. Owing to the separation of the pubic bones which is frequently present, this may be the most difficult part of the operation.

The operation may have a mortality as high as 25 per cent, and subsequent risks of ascending infection from the colon are ever present, but are minimised to a great extent by the sealing off of the peri-ureteral lymphatics by the method of uretero-intestinal anastomosis just described.

Patent Urachus. The urachus, which in the normal individual is represented by a fibrous cord passing from the umbilicus to the apex of the bladder, may in some cases fail to close and form either a cyst or a complete fistulous track with discharge of urine at the umbilicus. If the vesical end of the urachus is patent, a diverticulum will be seen near the apex of the bladder.

Treatment. A patent urachus or cystic swelling in some part of its course should be excised by a median suprapubic incision.

A diverticulum arising from the lower end of the urachus, if communicating with the bladder by a large opening, should be treated expectantly.

TRABECULATION AND DIVERTICULA

Trabeculation. The normal bladder, when viewed through a cystoscope, is perfectly smooth, except for the elevation of the inter-ureteric bar. Trabeculation is the term applied to elevations of the mucous membrane caused by the intravesical projection of the muscular bundles of the viscus (fig. 1617). When well marked, an appearance resembling the chordæ tendinæ of the ventricles of the heart is obtained with the formation of a complicated lattice work. Between



Fig. 1617.—TRABECULATED BLADDER.
CYSTOSCOPIC VIEW.

the bundles are depressions known as false diverticula. The appearance of the blood-vessels is not interfered with unless cystitis supervenes, when the changes characteristic of this condition are observed.

Trabeculation does not affect the trigone or the inter-ureteric bar, and in the earlier stages is confined to the retro-trigonal area and lateral recesses of the bladder. In the later stages the remainder of the viscus becomes involved, though the roof is never affected to the same extent as the floor.

Trabeculation may result from hypertrophy, from certain diseases of the central nervous system, or may be idiopathic.

(a) *Hypertrophic trabeculation*: This is usually seen when lower urinary obstruction is present, due either to prostatic enlargement, fibrosis or urethral stricture in males, and to cystocele in females, and illustrates the natural way in which the organ adapts itself to the increased work it has to perform on account of obstruction.

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(b) Trabeculation in nervous diseases: One of the earliest signs of tabes dorsalis is trabeculation of the bladder, and this is frequently present before the other manifestations of this disease have made their appearance. In a number of cases routine cystoscopy has suggested this diagnosis, which was subsequently confirmed by the Wassermann examination of the blood and cerebro-spinal fluid.

(c) Idiopathic trabeculation: This is occasionally seen in the absence of nervous disease or of obstruction of the bladder, being commoner in old people, and although of no significance, may account for an otherwise unexplained frequency of micturition.

Diverticula. (a) False diverticula. These are depressions between adjacent hypertrophied muscular bundles in the bladder. They are usually of irregular shape, shallow in depth, and are invariably multiple.

(b) True diverticula. A true diverticulum consists of a pouch lined with vesical mucous membrane, surrounded by fibrous tissue, fat, and often some non-striped muscle, and communicating with the bladder by a narrow opening. Owing to the small amount of muscular tissue in its wall, it is incapable of contracting completely and when once its contained urine becomes infected, this inability to empty itself constitutes the main reason why infection persists and continually re-infects the bladder. It is usually regarded as congenital in origin and has been seen in children, young adults and occasionally in the foetus. It is generally single and may attain a size as large as or larger than that of the bladder. Small diverticula are occasionally multiple.

A diverticulum is commonly situated above and to the outer side of one or other ureteric orifice. Its mouth is small and may demonstrate some degree of sphincteric action which occasionally accounts for its apparent absence during cystoscopy when it has already been seen at a previous examination. Lower urinary obstruction greatly encourages an increase in size.

Symptoms and Signs. These may be entirely absent or consist of micturition in two stages. A patient will empty his bladder, apparently completely, and a few seconds later experience a desire to micturate, and will often pass an even greater quantity of urine at the second attempt. This is due to the sudden emptying of the contents of the diverticulum into a bladder which has just voided its contained urine.

Cystitis is a common accompaniment and is most marked in the cavity of the diverticulum. The first specimen passed may be comparatively clear, while the second is purulent.

Attacks of frequency, difficulty, and even retention of urine may occur from the pressure of a diverticulum on the vesical neck from outside the bladder. Stones very commonly form in its cavity (fig. 1618), and innocent and malignant growths have been described growing from its walls at or near the opening (fig. 1619).

Back pressure and infection will eventually lead to pyelonephritis and other inflammatory changes in the kidney.

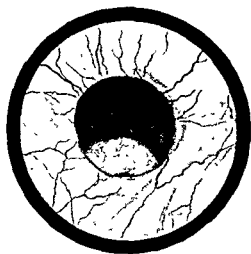


Fig. 1618.—STONE IN VESICAL DIVERTICULUM.

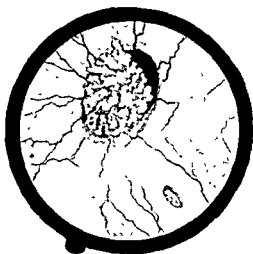


Fig. 1619.—PAPILLOMA PROTRUDING FROM VESICAL DIVERTICULUM.

Diagnosis. The symptoms, although usually puzzling, should lead to a routine examination and cystoscopy. Occasionally a large diverticulum can be felt bimanually.

Cystoscopic examination at once establishes the diagnosis, and a cystogram taken after the injection of 15 per cent sodium iodide into the bladder may gauge its size and position, especially if lateral X-rays are taken (see fig. 1533).

Treatment. If giving rise to no symptoms and discovered accidentally, a diverticulum of small size may be treated expectantly. One of larger size, however, is liable to become infected and this complication, once established, is extremely resistant to all methods of treatment and calls for removal of the sac.

Preliminary Treatment. The exact diagnosis of the size, shape, and position of the diverticulum, together with the presence of complications,

will have been established during the investigation of the patient. The renal function and the degree of infection present must be estimated. If the former is materially impaired and the latter is of marked degree, preliminary suprapubic drainage should be carried out, together with independent drainage of the diverticulum by means of a double tube which is passed down to the depths of its cavity. By this means the kidneys are relieved of all back pressure and the diverticulum is gradually cleansed by continuous irrigation.

The majority of large diverticula are situated above and to the outer side of one or other ureteric orifice and may burrow deeply into the retro-vesical tissues, with frequent formation of dense adhesions to the ureter, peritoneum, rectum, and iliac vessels. Good lighting, gentle handling, and infinite patience are essential factors for safety and success.

Operation. The pre-operative preparation and anæsthesia are described under Suprapubic Cystotomy on page 2975. Preliminary cystoscopy is carried out and a large ureteric catheter is passed up the ureter on the side of the diverticulum and left in position. A large cystotomy wound is essential. The patient is placed in the Trendelenburg position and self-retaining retractors are inserted to keep the recti muscles and superficial structures as widely apart as possible. With the fingers of one hand in the vesical cavity the peritoneum is cleared from the apex and posterior surface of the bladder as far as possible by gauze stroking. The urachus, when encountered, is cut across. If the peritoneum is accidentally opened it should be immediately closed by a continuous catgut suture. Stripping is continued until the neck of the diverticulum is reached. The fingers in the bladder are next slipped into the cavity of the diverticulum and its borders defined, which will help to identify the neck of the sac. By a combination of blunt dissection, gauze stroking and cautious snipping with blunt-pointed curved scissors the sac is gradually isolated from its surrounding structures, though this, in most cases, will prove the most difficult and tedious part of the operation.

The ureter is often adherent to some part of the posterior aspect of the diverticulum, but with preliminary ureteric catheterisation its separation is much facilitated; in some cases the ureter will have to be cut across and re-implanted into the bladder.

The vas deferens is usually adherent and, if separation is impossible, requires division and ligature of the two cut ends. Extreme gentleness

is required when adhesions between the sac and the rectum or internal iliac vessels are being divided.

Once the diverticulum is free it is cut away from the bladder, together with the hard fibrous ring which is almost invariably present between the two structures. A continuous suture of No. 2 chromicised catgut is inserted into the outer aspect of the cut margins of the bladder opening, after picking up its edges by means of long artery forceps. The vesical aspect is then examined after invagination of the suture line by a finger from without. Additional interrupted sutures are inserted if necessary from outside the bladder.

The bladder is closed with drainage around a Winsbury-White suprapubic tube and a second tube passed into the retro-vesical space from which the diverticulum has been removed. A careful search is made for any possible rent in the peritoneum, and if found this should be closed by a continuous catgut suture.

Complications. Pre-operative infection and depression of the renal function have already been mentioned. If a stone is present in the diverticulum its presence in no way affects the removal of the sac by the method just described. The presence of a growth, especially of the malignant variety, necessitates a much wider excision of the bladder wall surrounding its neck. If spread has already taken place beyond the wall of the diverticulum into surrounding structures the operation must be abandoned.

When prostatic enlargement and a diverticulum co-exist, the removal of the gland should in all cases be deferred to a later date.

Firm adhesions to the surrounding structures such as ureter, vas deferens, rectum, and large vessels on the lateral wall of the pelvis have already been referred to.

Provided that bladder-neck obstruction is absent there is usually no post-operative residual urine.

INJURIES OF THE BLADDER

Rupture of the bladder usually occurs when the viscus is distended, and may be either intra- or extra-peritoneal. The exciting cause is usually a kick or blow on the lower abdomen, but rupture may occur from an excessive effort to expel the bladder contents, as in some cases of stricture. Intra-peritoneal rupture is commoner than extra-peritoneal. In the former the symptoms are those of acute infective

peritonitis, and in the latter of a spreading suppurative infiltration of the pre-vesical tissues and lower abdominal wall (fig. 1620).

Symptoms and Signs. There is usually considerable pain and shock, together with the passage of small amounts of blood-stained urine accompanied by much strangury. If the rupture is extra-peritoneal, a rapidly increasing boggy swelling will be seen in the suprapubic region, but this is absent if the rupture is intra-peritoneal, when signs of free fluid within the peritoneal cavity will be elicited.

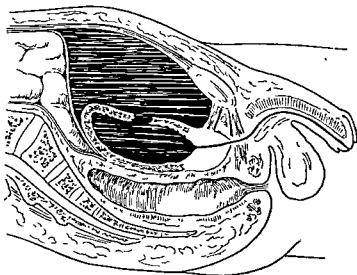


Fig. 1620.—EXTRA PERITONEAL RUPTURE OF BLADDER.
(After Bailey and Love.)

Diagnosis. This is made by the history of the accident, the symptoms and signs present, and the passage of a catheter which will fail to draw off more than a few drops of blood-stained urine, though occasionally a larger quantity may escape if the catheter passes through the rent.

Rupture of the urethra is characterised by the appearance of blood at the external urinary meatus independently of micturition, and the catheter is obstructed.

Fracture of the pelvis may be accompanied by retention of urine without rupture of the bladder, and a catheter will withdraw a large quantity of urine.

Treatment. Immediate suprapubic exploration is always indicated, and if extra-peritoneal rupture has occurred, the bladder should be drained with a large Winsbury-White suprapubic tube and two smaller tubes be inserted on each side of the viscus into the peri-vesical tissues.

no rent can be found in the extra-peritoneal aspect of the bladder, the peritoneum must be opened and the blood-stained urine removed in the peritoneal cavity.

The patient is placed in the Trendelenburg position and a search is made for the rent. If found, it is closed with a continuous stitch of catgut which takes up all the coats of the bladder with the exception of the mucous membrane. The suture line is inverted by another continuous stitch. A large catheter is passed per urethram and the bladder washed out with boric lotion, which serves to remove the blood-stained urine or blood clot, and to test the suture line. If this is found to be satisfactory, the abdomen is closed after placing a drainage-tube into the pelvis.

The catheter is left tied in for a week to ten days.

In some cases the intra-peritoneal rent is inaccessible, when reliance must be placed on the indwelling catheter and the peritoneal drainage alone.

CYSTITIS

Cystitis, or inflammation of the bladder, is caused by bacterial invasion of the vesical mucous membrane. Under the same heading, however, must be classed certain non-bacterial inflammations due to thermal, chemical, or mechanical causes. Bacterial invasion implies a source of infection which may be intra- or extra-urinary, and no effort should be spared in discovering and eliminating this, because treatment directed solely to the bladder is merely symptomatic and analogous to the local treatment of a gonococcal arthritis, without any attempt being made to cure the primary focus in the seminal vesicles or prostate. As a rule some predisposing factor is present in the bladder, which causes a lowered resistance, but in some cases of coli cystitis no such factor is discoverable.

The cardinal rules for the treatment of cystitis are :

- (1) General treatment during the acute stage, and avoidance of all forms of instrumentation, if possible.
- (2) The addition of local treatment, such as bladder wash-outs, during the sub-acute stage.
- (3) A complete urological and general investigation during the chronic stage to discover (a) the source of infection, and (b) the factor causing the lowered resistance in the bladder, and the elimination of both these where possible.

Factors causing lowered resistance.

- (1) Residual urine, e.g. due to prostatic obstruction, stricture, phimosis, meatal stenosis, cystocele, atony of the bladder, and certain nervous diseases such as tabes.
- (2) Injury of the bladder wall, e.g. by catheter, sound, or bruising during abdomino-pelvic and bladder operations.
- (3) Foreign bodies, e.g. stone.
- (4) Growths, e.g. primary, or secondary involving the bladder from the uterus or intestinal tract.
- (5) Congestion of the bladder, as may result from masturbation, chronic cervicitis, or other infections of the female genital tract.

Bacteriology. The commoner organisms are :

Bacillus coli	}	in acid urine.
Bacillus tuberculosis		
Gonococcus		
Bacillus coli	}	in neutral urine.
Streptococcus		
Staphylococcus	}	in alkaline urine. These two have the power to cause alkaline decomposition of the urine by splitting urea into ammonium salts.
Bacillus proteus		

Of these the *B. coli* is much the commonest. Mixed infections may occur.

Source of Infection.

- (1) From above, e.g. *B. coli* or tuberculous infection of the kidney.
- (2) From below, e.g. prostatitis, vesiculitis, urethritis, septic catheterisation, or vulvo-vaginitis in children.
- (3) Lymphatic spread, e.g. from cervix or intestine.
- (4) Fistula formation, e.g. cystotomy, vesico-intestinal, or vesico-vaginal.
- (5) Hæmatogenous infection, e.g. from teeth, tonsils, boils, carbuncles, etc.

Symptoms and Signs. *Acute Cystitis (non-tuberculous).* The cardinal symptoms of acute cystitis are frequency, dysuria, pyuria, and

often hæmaturia. The attack usually begins with a feeling of discomfort which soon increases in intensity until actual pain is felt in the suprapubic and perineal regions. Micturition becomes more and more frequent, and is accompanied by intense cramp-like pain at the end of the act, which is referred to the tip of the penis or labia majora. The urine is turbid with pus and organisms and is often blood-stained, the amount of blood increasing towards the end of micturition and being due to the contraction of the bladder on its own swollen and engorged mucous membrane. Because of the low power of absorption of the vesical mucous membrane, the temperature is rarely raised to over 100° F., except when a primary cause, such as a pyelonephritis or prostatitis, is present. In cases secondary to prostatitis or prostatic abscess retention may occur, necessitating the passage of a catheter.

Investigation. During the acute stage the diagnosis is made by a consideration of the symptoms and signs enumerated above. The presence of a urethral discharge or of a tender swollen prostate as felt per rectum will prove the presence of an ascending cause, while pain on pressure in one or other loin will suggest infection from above.

Bacteriological examination of the urine will identify the causal organism and permit the preparation of an autogenous vaccine if necessary.

The source of the cystitis is of little practical value during an acute attack, as treatment is directed towards the urinary tract as a whole until the disease becomes sub-acute or chronic. Instrumentation is only justifiable in cases of retention.

Treatment. The patient should be confined to bed and placed on a fluid or semi-fluid diet. Large quantities of Contrexéville, Vittel, or barley water are administered, and an alkaline mixture, such as the following, is given four-hourly :

R/	
Pot. bicarb.	25 grs.
Pot. cit.	20 grs.
Tinct. hyoscyami	20 m.
Tinct. belladonnæ	5 m.
Spt. chlorof.	10 m.
Aqua menth. pip.	ad ½ cz. Sig. ½ oz. 4-hourly.

The hyoscyamus and belladonna are anti-spasmodics. The bowels should be opened daily by salines, which tend to relieve pelvic congestion.

Fomentations to the suprapubic region and hot sitz baths two or three times a day are invaluable, and hot enemata followed by a morphia suppository give great relief. Heroin, $\frac{1}{8}$ gr. hypodermically, may be given six-hourly to enable the patient to sleep, and later be replaced by empirin compound 10-20 grs.

As the acute symptoms begin to subside, great relief will be afforded by irrigating the bladder with acriflavine 1 in 8000 after cocainisation of the urethra. The patient is allowed up and his diet gradually increased, but spiced foods, curries, meat, coffee and alcohol are forbidden.

In many cases the symptoms gradually disappear, but in a large number, especially when there exists some primary cause for the condition, chronic cystitis becomes established.

Chronic Cystitis (non-tuberculous). This may follow an acute attack or be chronic from the beginning.

Symptoms and Signs. These are similar to the acute form, but of a much milder character. Some frequency, mild dysuria and pyuria, and some vague suprapubic or perineal discomfort are complained of, but the frequency may gradually become more marked on account of the increasing contraction of the bladder. As a rule the cystitis is secondary to some focus of infection within or without the urinary tract, and one or other of the factors enumerated on page 2890 is present, causing a lowered resistance of the bladder.

No urological condition calls for more careful and complete investigation, and this should be carried out in all cases.

Routine Examination. Acute or chronic gonococcal urethritis will be recognised by examining the meatus for discharge, and by the bacteriological examination of the urine. Secondary infections following gonorrhoea will also be revealed in this way. Chronic genital infections usually leave some thickening of the epididymis, and rectal examination may give evidence of chronic prostatitis and vesiculitis. There may be a senile enlargement of the prostate or carcinoma of the gland. In the female, the cervix may show an erosion and other signs of chronic cervicitis, and a bimanual examination may elicit tenderness in the region of the tubes or some uterine displacement or deformity such as that due to fibroids or a retroverted uterus.

Abdominal examination may discover tenderness in one or both loins or the presence of an enlarged kidney. The bladder may be enlarged

and be seen rising up to the umbilicus. The eyes and reflexes may show that tabes is present.

The passage of a catheter will exclude a stricture or fibrous contraction of the bladder neck and determine whether residual urine is present or not.

The urine varies considerably. In the terminal stages of coliform infections there is merely a slight haze, whereas in chronic cystitis secondary to prostatic and stricture cases, especially when residual urine is present, it may be thick and foul-smelling. Bacteriological examination will reveal the nature of the infecting organism. Albumen, pus, and sometimes blood may be present.

Cystoscopic Examination. The passage of the cystoscope excludes a stricture and will show whether a local factor causing lowered resistance is present, such as an intravesical enlargement of the prostate, stone, or growth.

As cystitis occurs so frequently and in such a variety of conditions, a detailed account of its cystoscopic appearances is essential. The following description follows very closely that given by MacAlpine in his book on cystoscopy, and is divided into four headings: (1) Vascular changes. (2) Changes in the mucous membrane—(a) desquamation, (b) oedema, (c) ulceration, and (d) proliferation. (3) Inflammatory products—(a) mucus, (b) epithelium, (c) pus, (d) blood, (e) membrane, (f) products of urinary decomposition. (4) Changes in the musculature—(a) distension, (b) trabeculation, (c) false diverticula.

(1) *Vascular Changes.* The earliest sign is increase in size and number of the vessels, the colour of the mucosa becoming redder and duller (fig. 1621). Hæmorrhage may occur from rupture of some of the dilated vessels on to the surface of the mucous membrane, when the condition is described as *hæmorrhagic cystitis* (fig. 1622). In severer cases engorgement of the vessels is more marked until the appearance of the mucosa may resemble granulation tissue.

It is rare to find all parts of the bladder affected equally, different degrees of inflammation being observed in different areas.

(2) *Changes in the Mucous Membrane.* (a) *Desquamation:* This is responsible for the dull granular appearance of the mucosa due to poor light reflection from its surface. As regeneration of the mucous membrane occurs following an attack of acute cystitis and in some forms of chronic cystitis, epithelial proliferation may be excessive.

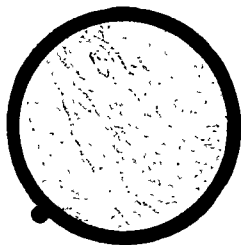


Fig. 1621.—CHRONIC CYSTITIS.



Fig. 1622.—HEMORRHAGIC CYSTITIS.

Exaggerated light reflection gives an added brightness to the surface, and minute glistening patches may be seen.

Pseudo-membranous trigonitis (fig. 1623) is a name given to the epithelial proliferation occurring on the trigone of females. It results from long continued irritation due to chronic cervicitis or urethritis, and is characterised by a fluffy, greyish-white adherent pellicle which never invades the vesical mucous membrane or ureteric orifices. In most cases the urine is normal, but in some cases organisms, pus, and even blood are present.

(b) *Cedema* : This gives rise to swelling of the mucosa. It is not always easy to see it through the cystoscope, except in the presence of some degree of trabeculation, when the muscular strands are observed to have a rounded swollen appearance instead of the usual clear-cut edge.



Fig. 1623.—PSEUDO-MEMBRANOUS TRIGONITIS.



Fig. 1624.—BULLOUS CEDEMA.

Œdematous thickening of the mucous membrane is often seen round the internal urinary meatus in females, and is commonly associated with chronic cervicitis and urethritis.

Bullous œdema (fig. 1624) resembles in appearance a cluster of grapes, and though often seen in cystitis is found independently of this and is due to lymphatic obstruction. It invariably occurs round the ureteric orifice if a stone is passing through the intra-mural part of the ureter, its extent varying with the degree of impaction of the calculus. It is also seen round the base of malignant growths and the margin of vesical fistulæ. Small isolated bullæ seen on the trigone and base of the bladder are commonly associated with a chronic *B. coli* cystitis.

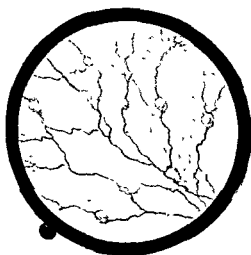


Fig. 1625.—CYSTIC CYSTITIS.

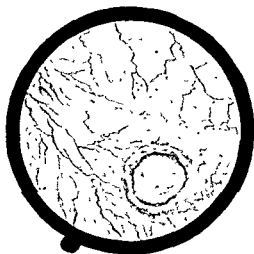


Fig. 1626.—HUNNER'S SOLITARY ULCER OF TRIGONE.

Cystic cystitis (fig. 1625) consists of isolated transparent cysts, much smaller than the bullæ of bullous œdema, which occur in the course of the minute blood-vessels of the mucous membrane. Sometimes these tiny cysts are stalked. They often occur in perfectly normal bladders, but as a rule there is a history of pre-existing chronic cystitis.

(c) *Ulceration*: Ulceration of the bladder may be due to heat, pressure, or cystitis, or may occur as a solitary ulcer of unknown origin.

(i) *Heat*. This type is, in most cases, the result of diathermy applied through a cystoscope by an electrode for the treatment of bladder growths or other lesions. At first a small area of mucous membrane is covered by a yellowish-white slough which is raised and surrounded by a ring of redness and swelling, sharply demarcated from the surrounding healthy bladder wall. The slough does not

separate until healing is well advanced, and thus erosion rarely occurs, but, if seen, consists of red healthy granulation tissue. The bluish margin of a healthy cutaneous lesion is never seen.

(ii) Pressure. Ulceration may result from the presence of a stone or foreign body in the bladder, or follow the tying in of a catheter. It is usually superficial, but in other ways resembles that due to heat.

(iii) Cystitis. Ulceration secondary to cystitis is rare, but occasionally a small, round, or oval ulcer with undermined edges and slight excavation of its base is observed in bacillus coli infections.

(iv) Solitary ulcer (fig. 1626). This is very rare, but may occur on the trigone. It has a deep cavity, a base covered by slough, raised clean-cut margins, and is surrounded by a small ring of congestion. The remainder of the bladder is invariably healthy.

(d) Proliferation: Long continued attacks of cystitis are frequently followed by thickenings and proliferations of the mucous membrane, the commonest variety resembling small areas of granulation tissue which may be sessile or polypoid. They are frequently found at the margins of a fistula or of a malignant growth (fig. 1627), and in tuberculous cystitis when secondary infection has occurred. Occasionally they may be mistaken for a neoplasm. In some cases small grey patches of hypertrophic mucous membrane are seen resembling leucoplakia of the tongue.

(3) *Inflammatory Products.* If a deposit is seen on the bladder wall it must necessarily be of pathological origin, as the normal mucosa is incapable of secretion. Such deposit may consist of mucus, epithelium, pus, blood, membranes, or products of urinary decomposition.

(a) Mucus. Mucus alone is difficult to demonstrate by cystoscopy as much of it is removed by the preliminary lavage of the bladder. In the urine glass it is shown by a flocculent deposit which settles at the bottom. When mixed with pus, small bands may be seen which cling to the wall of the bladder. Occasionally a thin glistening streak of mucus alone is present.

(b) Epithelium. (See "Changes in the Mucous Membrane.")

(c) Pus, as seen through a cystoscope, has a creamy-yellow, opaque, and somewhat viscid appearance which may be altered if mixed with blood, mucus, phosphates, or epithelium. If of vesical origin, it is usually possible to remove it by irrigation, though at times

shreds will adhere to an inflamed or ulcerated mucosa. When of renal origin, however, the gush from the ureter may be sufficient to render the medium opaque. Sometimes a semi-solid worm-like efflux (see fig. 1554) is observed emerging from one or other ureteric orifice, indicating extensive inflammatory changes in the corresponding kidney. Pressure over the diseased organ will often encourage its contained pus to pass down the ureter into the bladder.

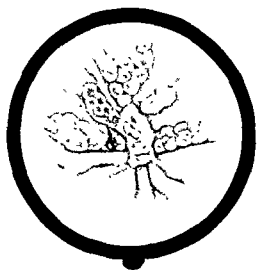


Fig. 1627.—INVASION OF BLADDER BY CARCINOMA OF UTERUS, WITH POLYPOID THICKENING OF SURROUNDING MUCOUS MEMBRANE.

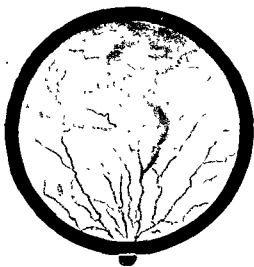


Fig. 1628.—BLEEDING FROM A TRIGONAL VESSEL.

(d) *Blood.* Bleeding is common if cystitis is present, and especially if congestion of the prostate has occurred. It may be produced by cystoscopy, however gently performed, and in some cases by over-distension of the bladder. It can occur in the form of a circumscribed oozing or of an actual rupture of a small artery (fig. 1628), when the characteristic spurting will be observed.

(e) *Membrane.* Membrane formation is common in cystitis, and varies from a thin film which may be localised or diffuse to thick adherent patches often obscuring underlying ulceration. The membrane is composed of mucous and desquamated epithelium, and, when partially detached, will be seen to float about in the distending medium.

(f) *Products of urinary decomposition.* Phosphatic deposits in the presence of ammoniacal decomposing urine are frequently seen on the floor of the bladder (fig. 1629) or covering any ulcerated area, such as occurs on a malignant growth. Oxalate stones which have descended from the kidney are especially liable to phosphatic incrustation. Excessive deposit of phosphates will, in time, give rise to soft friable

which may be conical (mulberry calculi) or spiculated. On section they are very hard and are irregularly laminated.

Uric acid stones grow rather more rapidly, are single or multiple and of a rounded or oval shape. Their surface is smooth or finely nodular, they are paler in colour than oxalate stones, and on section are hard and concentrically laminated.

Secondary calculi depend for their formation on two factors: bacterial decomposition and stagnation of urine, both of which are seen in many stricture or prostatic cases which are complicated by cystitis. They consist mainly of phosphates, are of rapid growth, and are usually soft and friable. They are of a dirty white colour, and on section are granular and do not show lamination. Phosphatic stones may have a nucleus of calcium oxalate or uric acid, suggesting that the

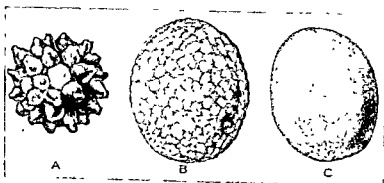


Fig. 1030.—VESICAL CALCULI. A. OXALATE CALCULUS. B. URIC ACID CALCULUS. C. PHOSPHATIC CALCULUS.

infection was secondary to the original stone which probably descended from one or other kidney. In some cases the nucleus consists of blood clot, a silk ligature, or some foreign body, such as a hairpin or fragment of catheter, introduced into the bladder through the urethra. Secondary calculi may be single or multiple. They are usually mobile, but may be fixed if formed around a ligature or wedged into a post-prostatic pouch, or gripped by thickened oedematous folds of mucous membrane.

Encysted stones may form in a diverticulum which is usually of the true variety. In some cases an apparently fixed stone is of a dumb-bell shape, one half lying in the bladder and the other half in a diverticulum.

Effects of a Vesical Stone. Hypertrophy and trabeculation of the bladder wall are common and may give rise to some degree of ureteric obstruction, with consequent back pressure on the upper urinary tract. This leads to varying degrees of hydro-ureter and hydronephrosis and

to chronic interstitial nephritis of the kidneys from fibrosis. Primary calculi sooner or later give rise to secondary cystitis, and ascending spread of this infection to the kidneys is only a matter of time, with disastrous results to the patient. Innocent and malignant growths are rare complications.

Symptoms and Signs. These consist of (1) pain; (2) hæmaturia; (3) frequency, and (4) alterations in the character of the urine and sometimes of the stream. There is frequently a history of an attack of renal colic due to the descent of the nucleus of the stone from the kidney. If the calculus is fixed, or if of large size and smooth, or if a number of faceted stones are present, there may be no symptoms at all.

(1) *Pain.* This is due to contraction of the bladder on the stone, and is increased if the latter is rough or spiculated, being thus greatest in the presence of an oxalate calculus. It occurs at the end of micturition, and is referred to the tip of the penis or labia majora, but often takes the form of intense griping in the perineum. The pain is worse during the day or on jolting, on account of pressure of the stone on the sensitive trigone; at night, when the calculus rolls back on to the less sensitive area of the bladder, pain may be absent. In children the pain is accompanied by screaming and pulling at the foreskin.

(2) *Hæmaturia* usually occurs, but is never profuse and is characterised by the appearance of a few drops of blood at the end of micturition.

(3) There is usually some increase in frequency of micturition, but in aseptic cases this occurs only in the day time.

(4) The urine may contain oxalate, uric acid, or phosphatic crystals, some pus cells, epithelial cells, and usually blood. The stream is as a rule normal, but may be intermittent from temporary obstruction of the internal urinary meatus by the stone; in children complete blocking and retention may occur. When infection supervenes, there is a constant suprapubic ache, an increase of all the symptoms, and the frequency and dysuria become equally marked by night as by day. The urine will contain pus, mucus and organisms, while frequently ammoniacal decomposition will occur producing a characteristic offensive odour.

In the case of secondary stones the symptoms are those of the primary condition, such as obstruction due to prostatic hypertrophy

or fibrosis, or to urethral stricture. In some cases phosphatic stones may form without producing any symptom which would suggest their presence. In other cases an exacerbation of symptoms occurs. Ascending infection to the kidneys will produce the characteristic symptoms of pyelonephritis, and in time lead to renal insufficiency and the death of the patient.

Diagnosis. This is made by a consideration of the symptoms, routine examination, cystoscopy, and X-rays. Previous attacks of renal colic or operations for stone are significant features, and the characteristic terminal dysuria referred to the end of the penis, and bleeding at the end of micturition, aggravated by movement and

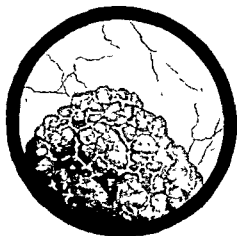


Fig. 1631.—OXALATE CALCULUS.
CYSTOSCOPIC VIEW.



Fig. 1632.—PHOSPHATIC CALCULUS.
CYSTOSCOPIC VIEW.

relieved by rest, should lead to a provisional diagnosis of stone. Examination of the external genitals and rectal examination may be normal or may reveal the presence of urethral or prostatic obstruction. A calculus can but rarely be detected bimanually, and then only if large and in a child.

Cystoscopic examination is essential and will give exact information as to the presence of the stone or stones, their size, position, shape, composition, and attachments (if any) to the bladder wall, or their relation to a possible diverticulum (figs. 1631 and 1632). The condition of the bladder can be ascertained and the presence determined of trabeculation, diverticula, intravesical projection of the prostate or a growth. The degree of secondary cystitis is observed, but much irrigation may be necessary before a clear view of the bladder can be obtained. In

children this examination should be carried out under an anæsthetic and a small "baby" observation cystoscope employed.

Difficulties in diagnosis may arise in the case of phosphatic incrustation of a malignant growth, and cystoscopic experience is essential for a correct interpretation.

Radiography should be employed as a routine (fig. 1633), not merely to verify the cystoscopic findings, but to exclude a stone in one or other half of the upper urinary tract. Reliance must never be placed solely on this method of examination for the diagnosis of a vesical



Fig. 1633.—PLAIN X RAY SHOWING A VESICAL STONE.
MULTIPLE VESICAL CALCULI ARE SHOWN IN FIG. 1529.

calculus, as in many cases a negative radiological report has been followed by positive cystoscopic findings, especially in the case of a large phosphatic calculus situated in a post-prostatic pouch.

Treatment. The treatment of secondary calculi must be regarded in the light of their causal disease; if this consists of prostatic hypertrophy necessitating prostatectomy, the stones are merely an incident and are removed during the preliminary cystotomy.

In stricture cases, preliminary dilatation will usually allow the subsequent extraction of the stones to be made by instrumental means. In the absence of such causes, litholapaxy is the instrumental procedure of choice for all primary and secondary stones, but certain conditions may render this impossible, e.g. too large a stone, or one not lying free in the cavity of the bladder, the presence of diverticula, growths, a contracted bladder, or severe and persistent cystitis, all of which call for suprapubic lithotomy.

Young male children must also be treated by operative measures.

Foreign Bodies. Foreign bodies may be introduced into the bladder through the urethra or make their way by ulceration through its wall. In the first category are included thermometers, thermometer cases, pieces of slippery elm bark, hairpins (fig. 1634), slate pencils, guides and the broken portions of a catheter. They occur chiefly in women, and in most cases are introduced by the patient. The second category is composed mainly of silk ligatures which have been used in operations on the female genital organs.

Symptoms and Signs. These depend on the shape of the foreign body and may be absent for some time if it is smooth and round. Infection is either introduced at the same time as the foreign body or is likely to

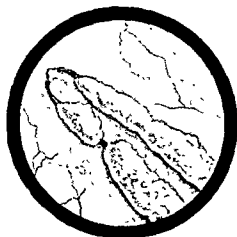


Fig. 1634.—HAIRPIN IN BLADDER, COVERED BY PHOSPHATIC DEPOSIT.

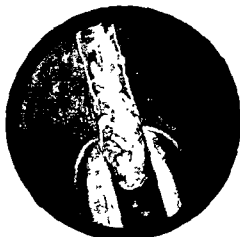


Fig. 1635.—PORTION OF CATHETER GRASPED BY YOUNG'S CYSTOSCOPIC RONGEUR.

occur shortly afterwards, when the symptoms of cystitis become superadded. If alkaline decomposition of the urine and phosphatic incrustation result, symptoms resembling a vesical calculus are produced.

Diagnosis. This is made by a consideration of the symptoms, routine examination, X-ray, and cystoscopy. Cystoscopic examination may reveal the nature of the foreign body, except when it is obscured by a complete coating of phosphates.

Treatment. Unless severe cystitis is present, an attempt should be made to crush off the phosphatic envelope by cystoscopic litholapaxy, especially in females, and to remove the fragments by an evacuating cannula and bulb. Extraction of the foreign body, if in the nature of a hairpin or thermometer case, is often subsequently possible by means

of Young's cystoscopic rongeur (fig. 1635) or cystoscopic forceps introduced through an operating cystoscope (fig. 1636). If the foreign body is a thermometer which is brittle, or of a shape rendering perurethral extraction impossible, there should be no delay in removing it suprapubically and draining the bladder for some days to diminish the severe cystitis which is so frequently present.

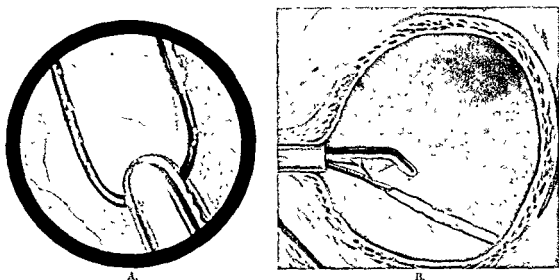


Fig. 1636.—WITHDRAWAL OF HAIRPIN FROM BLADDER BY CYSTOSCOPIC FORCEPS INTRODUCED THROUGH A CANNY RYALL OPERATING CYSTO URETHROSCOPE. A. CYSTOSCOPIC VIEW. B. SECTIONAL VIEW.

LITHOLAPAXY

Litholapaxy is the method of choice for the removal of stones, except when they are too large or not lying free in the bladder cavity.

The urethra must be capable of admitting a lithotrite of adequate size, any stricture or narrowing of the meatus being dealt with previously.

In some cases the calculus is merely a complication of or co-exists with other conditions requiring suprapubic drainage or removal, in which case it is extracted during the cystotomy. Such conditions include prostatic hypertrophy, diverticula, growths, and certain infections of the bladder and kidney which will not respond to simpler measures.

In this country the number of patients suffering from vesical calculus is limited and the urologist is rarely able to attain the skill of his Indian colleague. Fortunately the introduction of the cystoscopic lithotrite has more than made up for this lack of experience and is most satisfactory in the hands of the practised cystoscopist. By its means all parts of the calculus can be crushed into pieces small enough to



Fig 1637.—CANNY RYALL'S CYSTOSCOPIC LITHOTRITE AND OBTURATOR.

pass through the evacuating cannula before withdrawing the lithotrite. The best instrument is that of Canny Ryall, which is made in various sizes. It resembles the ordinary "blind lithotrite," but has a lateral cystoscopic sheath welded on to it, through which the telescope is passed and the bladder irrigated. An obturator is fitted during the passage of the instrument (fig. 1637).

Canny Ryall's cystoscopic evacuating cannula (fig. 1638) and bulb (fig. 1639), also made in various sizes, enable the surgeon to make sure that all fragments have been aspirated before removing the instrument.

Young's cystoscopic rongeur is an instrument which should always be at hand (fig. 1640). In some cases of soft phosphatic stone or of a stone which has formed round a ligature or foreign body, or for the extraction of an isolated fragment, it is invaluable.

As a rule during the operation only the first two instruments are passed, with the result that damage to the urethra is reduced to a minimum.

Preparation. It is rarely possible to reduce the degree of urinary infection by the use of drugs, and after diagnosis the sooner the stone is crushed the better.

Two vegetable laxative pills are given 48 hours before operation, a light diet on the day before, with plenty of glucose barley sugar to suck, and an enema early on the morning of the operation. The pubes and scrotum are shaved and painted with 3 per cent picric acid in spirit the night before.

Anæsthesia. Gas and oxygen preceded by intra-rectal avertin and $\frac{1}{100}$ gr. atropine is advisable.

Position. The patient is placed in the lithotomy position, care being taken to place thick wads of cotton wool between the calves of the legs and the lithotomy poles.

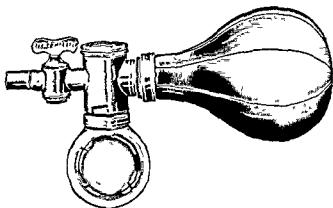


Fig. 1639.—CANNY RYALL'S EVACUATING BULB.

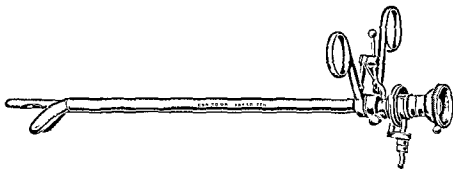


Fig. 1640.—YOUNG'S CYSTOSCOPIC ROUGEUR.

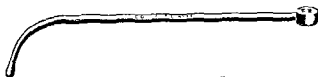


Fig. 1641.—LISTER'S STEEL SOUND.

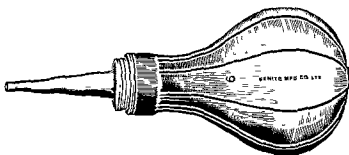
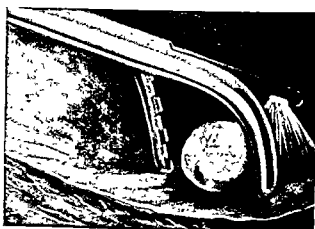


Fig. 1642.—SIX OUNCE BLADDER SYRINGE.

Operation. A 28/32 Charrière Lister's steel sound (fig. 1641) is passed to ensure the patency of the whole urethra. A cystoscopic lithotrite of a size suitable to that of the stone, with obturator in position and well lubricated with lubafax, is gently passed into the bladder in the manner described for the passage of a cystoscope (see page 2718), and held in position by a cystoscopic clamp. The obturator is removed and the bladder washed out with either boracic lotion (1 oz. to a pint) or oxycyanide of mercury 1 in 8000 until the return flow is clear, and distended with 10 to 12 ozs. of the solution introduced with two 6-oz. bladder syringes (fig. 1642). This amount is suggested as an average quantity, and is based on the consideration of two opposing factors: (1) During the crushing process the medium tends



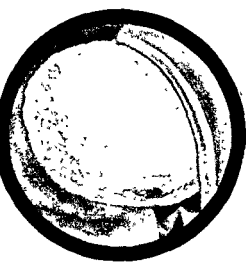
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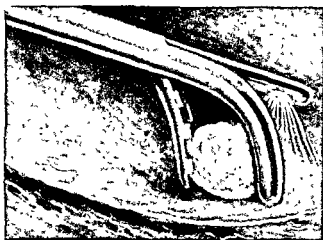
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Fig 1643.—CYSTOSCOPIC LITHOLAPAXY. JAWS OF LITHOTRITE ABOUT TO GRASP STONE.
A. CYSTOSCOPIC VIEW. B. SECTIONAL VIEW.

to become cloudy, and so the fuller the bladder the longer is visibility maintained: (2) Over-distension, especially in the presence of an inflamed vesical mucosa, tends to produce bleeding, which also obscures the view. Much experience is required to estimate the right amount of distension. The telescope, the terminal lamp of which has been tested, is passed down its sheath and the lithotrite rotated through 180° , so that its jaws are pointing downwards. The surgeon sits on a stool, clips on the cords, turns on the light switch, removes the cystoscopic clamp, and begins his inspection of the bladder, the lights in the operating theatre being dimmed. After locating the calculus or calculi, the jaws of the lithotrite are opened by turning the screw on the handle of the instrument, and the female, or fixed blade, accurately hooked over the centre of the stone (fig. 1643), which is firmly grasped by closing



A.



B.

Fig. 1644.—CYSTOSCOPIC LITHOLAPAXY. STONE GRASPED BY JAWS OF LITHOTRITE.
A. CYSTOSCOPIC VIEW. B. SECTIONAL VIEW.

the male, or moving blade, on it (fig. 1644). It is lifted well away from the bladder floor by depressing the ocular end of the lithotrite (fig. 1645), the telescope is withdrawn slightly to prevent breaking of the light bulb by stone fragments, and the calculus is crushed by firm but slow rotation of the screw until the male blade has fully engaged with the female (fig. 1646). The telescope is pushed home and another stone or fragment selected, grasped and crushed. The procedure is repeated until the surgeon is sure that the largest remaining fragment is small enough to pass through the evacuating cannula. At times, in spite of the most skilful manipulation, some degree of bleeding occurs which may obscure the view. In this case the bladder is emptied, washed

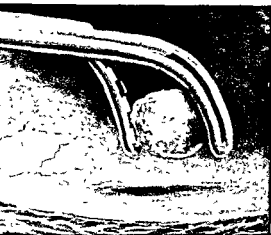


Fig. 1645.—CYSTOSCOPIC LITHOLAPAXY. STONE LIFTED AWAY FROM BLADDER FLOOR, TELESCOPE WITHDRAWN.
SECTIONAL VIEW.

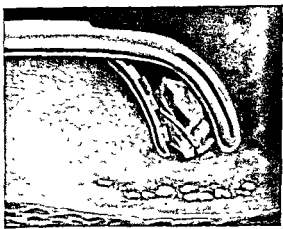


Fig. 1646.—CYSTOSCOPIC LITHOLAPAXY. LITHOTRITE CRUSHING STONE. SECTIONAL VIEW.

out two or three times, and re-distended. If still no view can be obtained, $\frac{1}{2}$ oz. of adrenalin 1 in 1000 is mixed with $\frac{1}{2}$ oz. of boracic lotion, injected into the bladder and left there for a few minutes, after which the viscus is again washed out and distended. Adrenalin, when injected directly into the bladder without coming in contact with the urethra, is perfectly safe in any concentration and is a most effective hæmostatic. When all fragments have been crushed, the telescope is removed, the obturator inserted and the lithotrite withdrawn, after rotating it through 180° so that the closed jaws are pointing upwards. The largest cystoscopic cannula that the urethra will admit is selected, well lubricated, the obturator inserted, and passed into the bladder. The obturator is removed and the stopcock immediately closed to prevent escape of lotion. The evacuating bulb, completely full of liquid and with closed tap, is connected to the cannula and both cocks are opened.

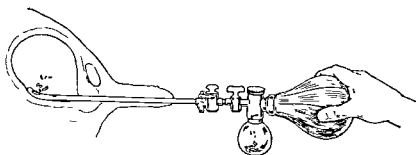


Fig 1647.—EVACUATION OF STONE FRAGMENTS WITH THE CANNY RIALL CYSTOSCOPIC EVACUATOR.

Aspiration is carried out by alternately compressing and relaxing the bulb, which is well elevated in order to press the beak of the cannula right down on to the bladder floor (fig. 1647). Compression of the bulb, by forcing fluid into the bladder, sweeps the fragments of stone off the floor. After each release of pressure, fluid rushes back from the bladder into the aspirating bulb, and fragments of stone which are sucked out strike the baffle, and drop into the glass receiver below. Sometimes the aspirating bulb fails to expand on relieving pressure. This is due to a portion of mucous membrane being sucked into the opening of the cannula or to its blockage by a stone fragment. A gentle squeeze of the bulb, with slight alteration in position of the cannula, will release the piece of mucous membrane. In the case of a piece of stone, sudden pressure on the bulb may eject it, but if this fails, the obturator is passed and the fragment pushed back into the bladder. Aspiration is continued with slight changes in the position of the cannula until no further fragments can be sucked out. The aspirating

bulb is then removed, and the bladder is emptied, washed out until the return flow is clear, and distended with lotion. The telescope of the cannula with tested bulb is introduced, the cords affixed, the light switched on and the vesical cavity thoroughly explored. Should any fragments of stone be seen, the aspiration process must be repeated. If a fragment should unfortunately be found which is too big for aspiration, but of a size permitting its passage through the urethra, an attempt may be made to extract it with Young's cystoscopic rongeur (fig. 1648).

The evacuating cannula is withdrawn, the rongeur passed, the obturator removed, and the bladder washed out and distended. The



Fig. 1648.—STONE GRASPED BY YOUNG'S CYSTOSCOPIC RONGEUR.

A. CYSTOSCOPIC VIEW. B. SECTIONAL VIEW.

telescope, with tested bulb, is inserted, and the instrument rotated through 180° so that its jaws point downwards. The blades are opened by drawing the handles apart and are closed on the fragment (fig. 1649). The telescope is withdrawn and the instrument removed after again rotating it through 180° . Should the fragment not permit of removal by Young's cystoscopic rongeur, it indicates faulty technique during the stone crushing, and this process, followed by evacuation, must be repeated.

When the surgeon is satisfied that the bladder is all clear, the telescope is removed, the viscus emptied, and a No. 12 or 14 English gum elastic catheter tied in and its position tested by a wash-out with lotion. A spigot is inserted and the patient returned to bed. The bladder is washed out twice daily for two days through the catheter, after which the latter is removed.

Complications. These are uncommon, and include hæmorrhage, catheter fever, and epididymitis.

Hæmorrhage during litholapaxy has already been described. If it continues after the operation, it is usually controlled by the indwelling catheter which in some cases may be left in for longer than two days.

"Catheter" or urethral fever and epididymitis are both due to infection, and are described elsewhere (see pages 3071 and 3045).

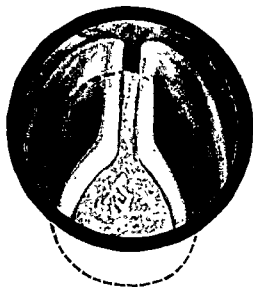


Fig. 1649.—STONE ENCLOSED IN JAWS OF
YOUNG'S CYSTOSCOPIC RONGEUR.

Suprapubic Lithotomy. Indications. (1) Vesical calculus when secondary to or associated with some condition which in itself requires operative treatment: (a) vesical calculus secondary to prostatic hypertrophy; (b) calculus associated with vesical growth or vesical diverticulum; (c) severe cystitis requiring suprapubic drainage.

(2) When disease of the urinary tract is present which has produced severe lowering of the renal function. In this case suprapubic lithotomy with bladder drainage is a safer procedure.

(3) The calculus. (a) Calculi of more than 2 inches in diameter are too big for lithotripsy, though the actual size of the stone which can be crushed depends very largely on the instrumental skill and experience of the surgeon. (b) With the modern lithotrite the hardness of a stone is in itself no contra-indication to litholapaxy. (c) An impacted calculus in the prostatic urethra which cannot be dislodged. (d) A calculus which is partly or wholly lying in a diverticulum (see fig. 1618).

(4) Urethra. Urethral stricture is no contra-indication to litholapaxy, as an adequate calibre can easily be acquired by preliminary dilatation with indwelling catheters.

Operation. The patient is prepared and anæsthetised and supra-pubic cystotomy is performed, as described on page 2975. The bladder wound is enlarged in an upward direction, two fingers of the right hand inserted into the vesical cavity and the diagnosis made by preliminary cystoscopy confirmed. At times, especially when multiple calculi are present, the cystoscopic findings must not be relied upon in themselves, as some small stones may have been obscured by the presence of larger ones. The calculi are removed either with a

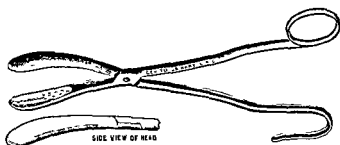


Fig. 1650.—LITHOTOMY FORCEPS.

finger or with lithotomy forceps (fig. 1650), and the bladder thoroughly explored after their removal, self-retaining retractors being used for this purpose if necessary.

Further procedures depend on the conditions which were diagnosed by cystoscopy and confirmed during operation—thus a diverticulum is removed and a growth fulgurated or excised.

In no case of calculus should a one-stage prostatectomy be performed. The closure of the bladder with drainage and the after-treatment are described on page 2978.

NEW GROWTHS OF THE BLADDER

New growths of the bladder are commoner in men than in women. They may be innocent or malignant, the former usually occurring between the ages of 25 and 40, and the latter between 40 and 60 years. The majority are of epithelial origin, but connective tissue tumours are occasionally found.

The bladder may be involved secondarily by malignant growths

of the uterus (see fig. 1627), or from the bowel, when a vesico-intestinal fistula may become established (see fig. 1676).

Secondary implantation of the bladder may also result from a villous carcinoma or papilloma of the renal pelvis, which spreads by continuity down the ureter.

(a) *Innocent New Growths* (epithelial origin). The commonest innocent vesical growth is a *papilloma* whose surface is covered with villi, and which is usually pedunculated (fig. 1651), but occasionally sessile. In two-thirds of the cases the growth is single. The area most frequently affected is situated above and to the outer side of one ureteric orifice, although no part of the viscus is exempt.

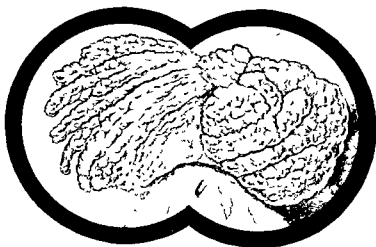


Fig. 1651 —LARGE INNOCENT VESICAL GROWTH. (Author's case.)

The pedicle is composed of a central core of fibrous tissue and of blood-vessels which are derived from the submucous coat of the bladder. The main mass of the tumour is composed of innumerable fine branches covered by transitional epithelium. There is no attachment to the underlying muscular tissue, as can be demonstrated at operation by drawing on the growth, which causes considerable elongation of the pedicle by taking up the surrounding mucous membrane.

Cystoscopically a papilloma varies from a delicate semi-translucent yellowish colour with long branching filaments which wave about in the fluid with which the bladder is distended, to a dull red with more coarsely arranged lobules which in some ways resemble a cauliflower. Though innocent pathologically, these tumours must be regarded as potentially malignant because secondary growths may arise by implantation, and recurrence is exceedingly

frequent after their removal, though not necessarily in the same situation.

If treatment is withheld, an apparently innocent papilloma may change its character by becoming irregular and sessile and may involve the subjacent muscular tissues, as shown by puckering of the surrounding mucous membrane (see fig. 1652). Owing to its delicate structure, ulceration, with consequent hæmorrhage, is extremely likely to occur, and cystitis, although absent in the early stages, may supervene, especially if instrumentation has been carried out. In neglected cases, death will ensue from hæmorrhage, cystitis, and ascending renal infection.

Symptoms and Signs. The cardinal symptom of a papilloma is painless hæmaturia, though, if complicated in the later stages by cystitis, the typical symptoms of the latter become superadded and consist of frequency, dysuria, and pyuria. A sudden burst of hæmaturia which is brought on for no apparent reason and ceases suddenly is a symptom which, without exception, calls for immediate urological investigation. The amount of bleeding may vary from a few drops at the end of micturition to a uniform staining of the urine indistinguishable from renal hæmaturia. It is due to blood being squeezed out of the papilloma by the contraction of the bladder wall, much in the same way as water out of a sponge, its amount depending on the degree of ulceration present. Unfortunately, the initial bout of hæmaturia, especially if of short duration, is often followed by a period of some weeks or months of complete freedom from all symptoms, which, in many cases, gives the patient a false sense of security which may even be shared by his medical attendant. During this period an increase in size of the growth is taking place, and in some cases the transition between innocency and malignancy has already occurred before a second bout of hæmaturia takes place. Pain, other than that due to cystitis, is rare, but may be produced by attempts on the part of the bladder to expel the growth, whereby a portion of it becomes caught and gripped by the internal urinary meatus at the end of micturition. Terminal dysuria, referred to the tip of the penis, will ensue and fragments of growth will occasionally be found in the urine from which, however, no differentiation between innocency and malignancy can be made. Retention from complete blocking of the posterior urethra and clot retention from excessive hæmorrhage are both rare.

Diagnosis. This is made by a consideration of the symptoms, routine examination, and cystoscopy which is always essential if a

patient complains of painless hæmaturia. Examination of the external genitals is normal, as is the rectal examination of the prostate and bladder base. The urine may or may not contain blood, depending on whether an attack of hæmaturia is in progress, and occasionally fragments of growth are found. Pus and organisms are present if secondary infection has occurred.

Cystoscopy is the sole method of establishing the diagnosis, and no great experience is necessary to distinguish between a typical innocent papilloma and a malignant growth. An innocent papilloma is characterised by its pedicle and by its delicate semi-translucent villi, which float in the fluid medium in the bladder of a patient usually under the age of 40 years. A malignant growth is sessile, with irregular,

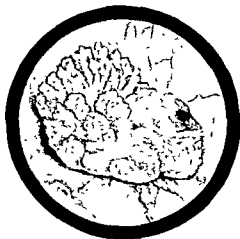


Fig. 1652.—PAPILLOMA SHOWING COMMENCING SIGNS OF MALIGNANCY.

stunted villi, and occurs in older people. Surrounding infiltration and puckering of the mucous membrane and often bullous œdema are present. Areas of necrosis can usually be seen on its surface, and bleeding during cystoscopy is the rule.

A borderline case (fig. 1652) which exhibits characteristics of both the foregoing varieties is most difficult to diagnose, even with great cystoscopic experience, and the exact character of the growth is frequently ascertained only after operative removal followed by microscopy, or by the result of diathermy treatment.

A growth covered by phosphatic incrustation is generally malignant and may resemble a stone.

Treatment. Innocent papillomata may be removed by either the per-urethral or the suprapubic route. Per urethram, the growth is destroyed

by diathermy applied through an electrode. This may be carried out either in a series of treatments under local anæsthesia in the consulting room, in an out-patient department, or under general anæsthesia in a nursing home or hospital, where massive fulguration is applied to the growth with a big terminal introduced through an operating irrigating cystoscope.

By the suprapubic route the bladder is opened by cystotomy and the growth either excised, preferably with a diathermy knife activated by the cutting current, or fulgurated by large flat electrodes. Whichever method is used it cannot be too strongly emphasised that the patient must be cystoscoped at three-monthly, then six-monthly, and finally at yearly intervals for the rest of his life, as, although the removal of the growth is comparatively easy, no guarantee from future recurrence, either at the same site or in entirely fresh situations, can be given, since the ætiology of a vesical papilloma is unknown and the cause of the original growth is quite impossible to eradicate in the light of our present knowledge.

(b) *Malignant New Growths* (epithelial origin). Carcinoma of the bladder is usually of either the squamous- or spheroidal-celled variety, and may occur in three distinct forms :

(i) *Malignant papilloma*. This in some ways resembles an innocent papilloma, and may be pedunculated or sessile (fig. 1652). The villi, however, are more closely arranged and are irregular and stunted. If a pedicle is present, it is much thicker and harder and, as a rule, some induration and puckering of the surrounding mucous membrane is evident. Irregular sloughing is a prominent feature.

(ii) *Epitheliomatous ulcer* (fig. 1653). In this variety, there is a flat irregular area usually on the floor of the bladder with everted edges and an ulcerated base.

(iii) *Diffuse nodular growths*. These consist of sessile, multiple tumours which show an occasional tendency to the formation of villi which are flat and stunted (fig. 1654). Any part of the bladder may be involved and secondary infection is exceedingly common.

Whatever the variety of growth, infiltration of the submucous and muscular tissues soon takes place with involvement of the nerve supply, and, in the later stages, of the prostate and vesicles with rapid spread to the neighbouring lymph glands and other structures on the floor of the pelvis. Adhesions to and perforation into the vagina, uterus,

rectum and intestine may occur, and in rare cases secondary deposits are found, most commonly in the lungs and liver.

Symptoms and Signs. As in innocent growths, the earliest symptom is painless hæmaturia, which may at first be intermittent. Soon, however, it becomes continuous and severe exacerbations of hæmorrhage may occur. Frequency is an early symptom in the majority of cases, and though usually due to cystitis, can be present without secondary infection, and is equally marked by night as by day. Pain may occur early or be delayed for a time if the growth is of the papillomatous type, and is due to cystitis or nerve involvement. The former is terminal and is felt at the end of the penis; the latter is referred to the



Fig. 1653.—EPITHELIOMA OF BLADDER.



Fig. 1654.—NODULAR CARCINOMA OF BLADDER.

suprapubic region, to the perineum and; in the later stages, down the backs of the thighs from involvement of the sacral plexus. This pain can be exceedingly severe and is slowly progressive, leading to rapid exhaustion of the patient from loss of sleep. The urine may be clear in the early stages, but usually bleeding and infection are present, and occasionally portions of growth.

Diagnosis. This is made by a consideration of the symptoms, routine examination, and cystoscopy. Two clinical types of the disease are described: in the common variety hæmaturia is the chief symptom, as with an innocent growth. In the less common variety, symptoms of cystitis are the most marked features, the condition thus resembling stone, innocent enlargement, or malignant disease of the prostate.

Examination of the external genitals is normal, but rectal examination will often reveal a thickening or the presence of a hard plaque in the region of the bladder base beyond the prostate. Occasionally a soft doughy mass can be palpated in this situation.

Cystoscopy is essential for establishing an exact diagnosis, and no difficulty is experienced if a typical carcinomatous ulcer or malignant papilloma is present, having on its surface areas of ulceration with surrounding infiltration of the bladder wall. As has been stressed under "Innocent Growths," the borderline case is the one presenting the greatest difficulty, and the exact character of the tumour can only be determined by microscopy after operation, or by observing the effect of diathermic fulguration, each treatment, in the case of an innocent growth, being followed by a definite diminution in the size of the tumour. During cystoscopy a careful search should be made for the presence of secondary growths.

The removal of portions of growth by cystoscopic forceps or Young's cystoscopic rongeur is deceptive, as subsequent pathological examination frequently suggests a benign condition when in reality a malignant tumour is present.

Treatment. (1) *Resection*: A frankly malignant growth, if in a situation which is accessible by surgical means, should be removed suprapubically with the whole thickness of the bladder wall and a surrounding healthy margin. The diathermy cutting current will be found exceedingly useful for excision of such tumours. If the ureteric orifice and intra-mural part of the ureter are involved, implantation of the ureter into the upper part of the bladder wound will be necessary.

(2) *Cystectomy*: In advanced cases of malignant disease the only treatment which offers any hope of cure consists of the implantation of the ureters (usually into the bowel), followed by complete removal of the bladder. Unfortunately, both resection and cystectomy are often rendered impossible by the general condition of the patient and the state of the renal function, when palliative methods become the sole form of treatment.

(3) *Perurethral diathermy*: Cystoscopic diathermy is only justifiable in borderline cases in which it is impossible to establish a diagnosis of either innocency or malignancy. The in-patient or nursing home method should be adopted, and as much as possible of the growth

destroyed at one sitting by the use of a large terminal and an operating irrigating cystoscope. If cystoscopic examination a month later does not show a marked improvement, no time should be lost in excising the growth suprapubically.

(4) *Palliative treatment*: (i) *Operative*. Growths unsuitable for resection or cystectomy, either on account of their position or of the general condition of the patient, may be fulgurated suprapubically by large flat electrodes, or sometimes by the perurethral route with a large cystoscopic terminal. By this means many of the distressing symptoms, due to cystitis, are diminished and the patient's life made tolerable for many months. Clot retention, if not relieved by an evacuating cannula and bulb, is occasionally an indication for cystotomy. Permanent cystotomy, though of great value in diminishing cystitis, by the establishment of suprapubic drainage with its easier means of washing out the bladder, is useless for the relief of painful spasms due to nerve involvement and may even add to the patient's discomfort. Implantation of the ureters into the bowel is equally valueless for a similar reason.

(ii) *Medical*. Profuse hæmaturia may respond to bladder wash-outs or continuous irrigation with hot silver nitrate solution, 1 in 8000, through a two-way catheter. If a catheter is employed, instillations of adrenalin are safe and may be efficacious. Injections of coagulen-ciba are useful. Pain may be relieved at first by empirin compound, 10–20 grs., or by morphia and belladonna suppositories, but in the later stages, hypodermic injections of ever-increasing doses of morphia or heroin become necessary. Pain due to cystitis can be alleviated to some extent by bladder wash-outs, and, as the urine is frequently alkaline, producing phosphatic incrustation of the growth, 10 to 20 minims of concentrated hydrochloric acid to a pint of water will be found useful as an irrigating fluid. Hexamine, 10 grs., before meals and an acid mixture after meals may be tried, but these drugs are often badly tolerated.

(c) *Connective Tissue New Growths*. Innocent connective tissue growths include myomata, fibromata, fibromyomata, and myxomata, but are very rare.

Malignant new growths are sarcomata. These are occasionally found in the extremes of life, arising from the submucous or the perivesical areolar tissue. Pedunculated and sessile varieties occur and their treatment is similar to that of epithelial tumours.

Treatment of Growths of the Bladder.

(1) Perurethral route : Cystoscopic diathermy.

(a) Out-patient or ambulatory method.

(b) In-patient or nursing home method.

(2) Suprapubic route : (a) Diathermy with or without excision.

(b) Partial cystectomy.

(c) Complete cystectomy.

Genito-Urinary Diathermy Machine (fig. 1655).

In genito-urinary surgery, high frequency currents possessing distinct physical characteristics are used, the two principal modalities being the diathermy *coagulating* and the diathermy *cutting* currents. These differ both in their electrical qualities and in their action on the tissues.

High frequency currents constitute a form of electrical energy which does not stimulate motor nerves and can be applied to the body in sufficient strength to produce a local effect without causing injury to the organism as a whole. These currents can be briefly described as being alternating in character with a frequency above 10,000 cycles per second, though in actual practice the number of oscillations are more of the order of one to six million per second.

For use in surgery the currents are generated by means of an oscillatory circuit consisting of (1) the condenser ; (2) the spark gap ; and (3) the solenoid, connected in series so as to form a closed circuit of low ohmic resistance.

When the condenser is connected to a suitable source of supply (low frequency alternating current), the potential of this charge is gradually built up until it is sufficient to overcome the resistance of the air space between the spark gap electrodes. When this has been reached, the energy stored up in the condenser will discharge in a rapid succession of oscillations across the ionized air space and will generate high frequency currents in the conductors composing the circuit.

This phenomenon goes on with decreasing amplitude of the oscillations until the condenser is discharged. If the condenser remains connected to the supply source it will immediately regain its charge and repeat the process described, so that groups of oscillations with short intervals between them are produced.

Each group starts with maximum amplitude which rapidly falls to

zero, owing to various losses in the circuit called "damping losses." The rate at which these groups of oscillations occur is termed "spark train frequency," and this, with the "damping" factor, has an important bearing in the action of high frequency currents on the tissues.

Highly damped groups of oscillations, with relatively long intervals between each, are characteristic of the diathermy coagulating current, whilst undamped or only slightly damped oscillation groups, with no perceptible interval between each, are characteristic of the diathermy cutting current.

The machines generating these two forms of current have much in common. They consist of:

- (1) Static high tension transformer, which raises the voltage of the mains supply for charging the condenser.
- (2) Condenser, in which the electrical energy is stored, until it has reached a potential which will break down the insulation of the spark gap.
- (3) Spark gap, between whose electrodes the discharge takes place.
- (4) Oscillating coil or inductance, in which the electro-magnetic waves are principally generated.

The capacity of the condenser and the shape and size of the inductance determine the frequency of the oscillations, while the design of the transformer and the spark gap, to some extent, control the spark train frequency for a given circuit.

The inductance usually consists of two separate coils, one fixed and connected in series with the condenser and spark gap, the other in close proximity to the first one, but arranged in such a way that its position in relationship to the fixed coil can be altered.

In technical language this is described as a "coupled circuit." The movable coil has no direct connection with the primary or fixed coil, so that the current circulating in the former is the result of mutual induction. By changing the position of the movable coil the strength of the current can be regulated.

From the ends of the movable coil, suitable conductors lead the current to the patient, and in this circuit are included two small balancing condensers and an ammeter.

The electrical constants of the components of a diathermy apparatus are designed to produce highly damped oscillations with a frequency of one to two million cycles and the resultant current is delivered at a potential sufficiently elevated to overcome the tissue resistances.

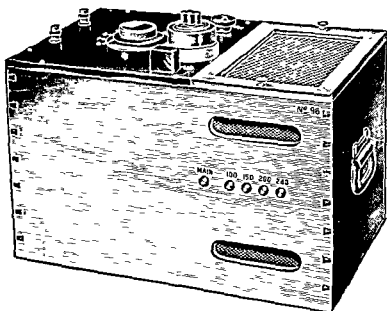
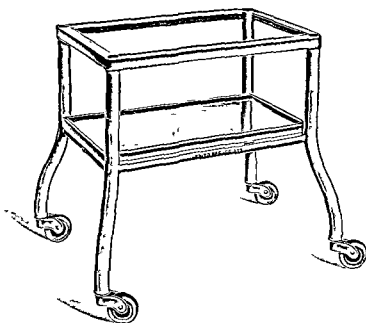
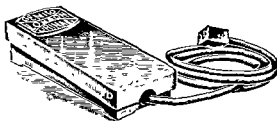


Fig. 1653.

A.—GENITO-URINARY DIATHERMY AND DIATHERMY CUTTING
CURRENT MACHINE.



B.—STAND FOR DIATHERMY MACHINE.



C.—FOOTSWITCH FOR USE WITH DIATHERMY
MACHINE.

Such a circuit, as described above, can be adapted for the generation of a cutting current in the following way: The spark train frequency must be increased by alteration of the spark gap and the damping losses reduced to a minimum by eliminating the moving coil and generally the ohmic resistance of the circuit. The patient in this case is directly connected to the oscillating coil. The oscillating constant of the circuit is reduced so that "spark trains" oscillate at five to six million cycles per second. The resulting current is only slightly damped and has all the characters of an almost uniform high frequency alternating current, but the current does not penetrate tissues to the same extent as a damped current.

If this current is applied by means of a fine needle or wire loop electrode an intensely hot arc is formed; this disrupts the tissue cells at the point of application in the same manner as a sharp instrument—in other words, it cuts. The action is similar to that of an oxy-acetylene flame on metal, the destructive arc being essentially local in action and without marked spread of heat to adjoining parts.

Both cutting and coagulating currents are applied in the same way, that is, by means of an active and of an indifferent electrode. The latter is generally constructed of a lead plate of such a dimension that the current density per surface unit never reaches a value which would produce redness of the skin. A plate 8 in. \times 6 in. answers the purpose for most surgical work, though in some cases it is better to employ a broad leaden belt round the patient's abdomen. It is essential that the whole surface of this indifferent electrode should be in contact with the patient's skin. The practice of interposing a pad soaked in strong salt solution has the double advantage of ensuring contact and lessening the resistance of the skin.

(1) *Perurethral route*: Cystoscopic diathermy.

This can be carried out in two different ways: (a) Out-patient or ambulatory method, under local anaesthesia; and (b) In-patient or nursing home method, under general anaesthesia.

(a) *Out-patient or Ambulatory Method*. The great advantage of this method is that it need not interfere with the patient's occupation, and is carried out in the consulting room or out-patient department at fortnightly intervals. When most of the growth has been destroyed the intervals are increased and the patient finally attends once a year for cystoscopic examination as a precautionary measure.

Although growths can be removed by diathermy, their cause of

origin is unknown, and this presumably is still present after treatment, which emphasizes the importance of an annual examination in order to anticipate any possible recurrence.

Ambulatory perurethral diathermy is the method of choice for innocent growths and for certain borderline cases in which a definite diminution in size is observed after each treatment.

Preparation. The patient is placed on hexamine 10 grs. before meals, and an acid mixture after meals for at least three days before each treatment. At the end of the sitting an alkaline draught is given, together with empirin compound 10 grs. and quinine hydrochloride 4 grs. Alkalis are continued for three days to allay post-instrumental dysuria, and are followed by hexamine and acids for at least another three days. It is wise to arrange for the treatment to take place late in the day, so that the patient may go straight home to bed.



Fig. 1656.—FLEXIBLE ELECTRODE WITH FLAT, CYLINDRICAL AND POINTED ENDS.

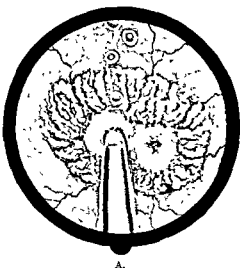
Essential Equipment. Cystoscopic couch and clamp. Irrigating stand filled with oxycyanide of mercury 1 in 8000 at 105° F.

Single catheterising cystoscope.

Diathermy electrodes (fig. 1656).

Diathermy machine, footswitch, cables, and lead belt.

Technique. The patient, if a male, is directed to pass all his water and is anaesthetised as described on page 2690. In the female no anaesthetic is necessary. The lower garments are removed and the patient is placed in the lithotomy position on the cystoscopic couch, the leaden belt buckled round the waist and connected to the diathermy machine. The penis, with retracted prepuce, or the vulva, is washed with lotion and the part isolated with a lithotomy towel. In cases of small or medium-sized growths situated in an accessible position, a single catheterising cystoscope with tested light is selected, lubricated with lubafax and passed into the bladder, where it is fixed by the cystoscopic clamp. The viscus is washed out until the return flow is clear and distended, care being taken to cease the moment the slightest discomfort is noticed. The telescope is inserted and the largest diathermy electrode that will fit the sheath is passed and connected to the other cable of the machine. The light cords are attached, the light switched



A.



B.

Fig. 1657.—DIATHERMY TO INNOCENT VESICAL PAPILLOMA. A. CYSTOSCOPIC VIEW. B. SECTIONAL VIEW.

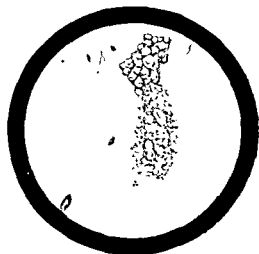
on and treatment begun, the surgeon sitting in front of the patient. The clamp is removed, and after a brief survey of the bladder and growth, the electrode is brought into the field of vision by pushing it further into its sheath. By a combination of the three processes of pushing the electrode further into the bladder, turning the Albarran lever which deflects it, and general movements of the cystoscope itself, contact is made with the most prominent part of the growth. The current is then turned on by the footswitch. Bubbles of hydrogen gas at once appear at the tip of the electrode and the growth quickly turns white by coagulation over an area varying in size with the strength of current used (fig. 1657). After a few seconds the current is turned off and the electrode is moved away, when a small black pit will often



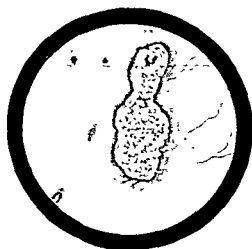
Fig. 1658.—VESICAL PAPILLOMA AFTER TREATMENT. CYSTOSCOPIC VIEW.

be seen at the centre of the coagulated area, showing where actual burning of the growth has occurred at the point of contact. Frequently this charred area adheres to the electrode and a sharp pull is required to free it, when a portion of growth may come away and necessitate removal by withdrawing the electrode into its sheath. This usually knocks off the adhering portion of growth but, if it fails, the electrode must be completely withdrawn and the metal tip cleaned. Diathermy, if possible, is applied successively to every part of the surface of the growth which is visible (fig. 1658), the number of treatments depending on the tolerance of the patient and the size of the growth.

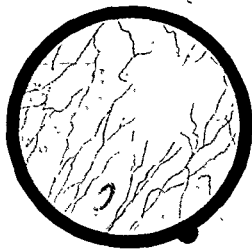
During the earlier treatments when the electrode is at some little distance from the bladder wall from which the growth is springing, a



(A) BEFORE SIXTH TREATMENT.



(B) AFTER SIXTH TREATMENT.



(C) LEFT URETERIC ORIFICE AND SCAR OF GROWTH
3 MONTHS AFTER FINAL TREATMENT.

Fig. 1658.—STAGES OF TREATMENT OF THE GROWTH SHOWN IN FIG. 1657.

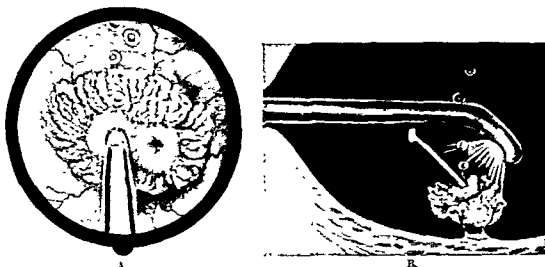


Fig. 1657.—DIATHERMY TO INVOLUCIST VESICAL PAPILLOMA. A. CYSTOSCOPIC VIEW. B. SECTIONAL VIEW.

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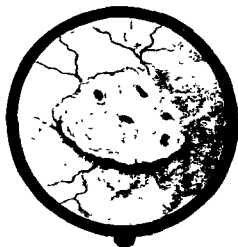
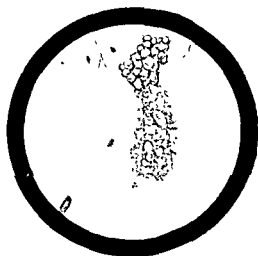


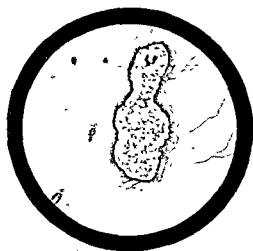
Fig. 1658.—VESICAL PAPILLOMA AFTER TREATMENT. CYSTOSCOPIC VIEW.

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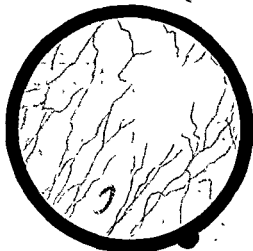
During the earlier treatments when the electrode is at some little distance from the bladder wall from which the growth is springing, a



(A) BEFORE SIXTH TREATMENT.



(B) AFTER SIXTH TREATMENT.



(C) LEFT URETERIC ORIFICE AND SCAR OF GROWTH
3 MONTHS AFTER FINAL TREATMENT.

Fig. 1659.—STAGES OF TREATMENT OF THE GROWTH SHOWN IN FIG. 1657.

stronger current and the largest electrode are employed, thus enabling the maximum amount of tissue to be coagulated at one sitting. The electrode can also be pushed into the substance of the growth, which will produce a more extensive effect but may cause small explosions, which can be seen and heard, due to the excessive generation of gas within its substance. During the later treatments, as the bladder wall is approached a smaller current and electrode are used. Figure 1659 illustrates the progress of the treatment of the growth drawn in figure 1657.

An innocent growth is devoid of nerves, and so no pain whatsoever should be felt while treatment is confined to the growth itself; but when only the pedicle remains, the final treatment may cause some discomfort from the close proximity of the sensitive mucous membrane, a small area of which should always be destroyed. Pain during preliminary sittings is a point in favour of malignancy, and should always be regarded seriously.

At the end of the sitting the cystoscope is clamped and the electrode and telescope are withdrawn. The bladder is emptied and washed out until the return flow is clear, and the cystoscope is unclamped and removed.

Sloughs as a rule begin to separate about the fifth day and continue to do so until the tenth or twelfth. At the end of a fortnight there is usually no slough visible and the growth is ready for another application of diathermy.

Difficulties and Complications.

(1) *Cloudy Urine.* As a rule after two or three bladder wash-outs the return flow becomes clear, but in some cases, in which secondary infection is severe, several pints of lotion may be required before a view can be obtained. Between each wash, pressure should be applied to the suprapubic region to ensure complete emptying of the viscus, which is the secret of rapid clearing of the fluid.

During treatment, the medium may become cloudy due to pieces of growth breaking off, the loosening of muco-pus from the bladder wall, or to bleeding obscuring the view, when treatment must be stopped and the bladder washed out until the return flow is again clear, after which the viscus is re-distended.

(2) *Hæmorrhage.* This may occur before, during, or soon after diathermy, or be due to secondary hæmorrhage from separation of the sloughs; its treatment in either case will depend on its severity.

It is obviously impossible to carry out treatment while bleeding is in progress, but there are several ways in which an attempt can be made to arrest it. In mild cases bladder washing may be enough to afford a clear view to permit of diathermy to the growth. If a bleeding point can be seen, the electrode should at once be applied to it and the area coagulated, by which the vessel is immediately sealed. Another wash will then produce a completely clear medium.

In more severe cases the bladder is emptied and $\frac{1}{2}$ oz. of adrenalin 1 in 1000 mixed with an equal quantity of lotion is injected through the cystoscopic sheath and allowed to remain for a few minutes, after which the bladder is again washed out. Sometimes the process has to be repeated before a view can be obtained. The injection of adrenalin is perfectly safe owing to the low power of absorption of the bladder mucous membrane. The urethral mucous membrane, however, is extremely absorptive, and dangerous complications may arise if this drug comes in contact with it. Injections must therefore only be made through a catheter or cystoscopic sheath.

In extreme cases of vesical hæmaturia, after preliminary washing, the bladder is distended with liquid paraffin which is transparent and will not mix with blood, and diathermy applied to the bleeding point or points.

Should all these methods fail and the patient's condition become serious, suprapubic cystotomy should be performed as an emergency measure and the bladder drained after open diathermy to the growth.

(3) *Clot Retention.* This is due to clotting of blood in the bladder, with the formation of large semi-solid masses which may block the internal urinary meatus, causing partial or complete obstruction. An attempt may be made to wash these out, using a large cystoscopic evacuating cannula and evacuating bulb, followed by bladder washing with oxycyanide of mercury 1 in 8000. The success of the procedure can be gauged by distending the viscus and inserting the telescope. If a view can be obtained and all clots have been removed, the hæmorrhage is dealt with as has been described. If this method fails, emergency suprapubic cystotomy must be performed, hæmorrhage arrested, and the bladder drained.

(4) *Situation of the Growth.* As a rule innocent growths are situated above and to the outer side of one or other ureteric orifice, where they are easy to treat, but occasionally they spring from other parts of the bladder. If small and arising exactly from the bladder neck (B fig. 1660), it may be possible to reach them with the single catheterising

cystoscope. But more usually they spring from the bladder just above the internal sphincter (A fig. 1660), or just within the posterior urethra (C fig. 1660). In the former case it is extremely difficult to see them and impossible to treat them without a retrograde cystoscope (B fig. 1662); and in the latter case a direct vision urethroscope must be used (fig. 1661). (See "Urethroscopy," page 2708.)

(b) *In-patient or Nursing Home Treatment.* This is indicated for large growths, certain borderline growths, and in cases where the patient is anxious to obtain a cure as quickly as possible and is able to devote the required time to the treatment. It is also necessary if the bladder



Fig 1660.
GROWTHS AT
BLADDER NECK.



Fig 1661.—PAPILLOMA SPRINGING FROM UPPER MARGIN
OF BLADDER NECK. URETHROSCOPIC VIEW.

is irritable, and for patients who are, for some reason or other, intolerant of instrumentation under local anaesthesia. An operating irrigating cystoscope and large electrodes are used, so that the maximum result can be obtained by one treatment, which is invaluable for large growths and essential for borderline cases.

Preparation. This is the same as for the ambulatory method, but in addition a good bowel action and a perineal shave are necessary the day before operation.

Equipment. This is the same as for the ambulatory treatment except that an operating irrigating cystoscope, such as Winsbury-White's (fig. 1662), and large diathermy electrodes (No. 12° Charrière) are used. An operating table replaces the cystoscopic couch.

Anæsthetic. Intra-rectal avertin and atropine $1\frac{1}{8}$ gr. followed by gas or oxygen is advised.

Position. Lithotomy.

Technique. The leaden belt is fixed round the patient's waist and connected to the diathermy machine. The external genitals are swabbed with spirit and the parts isolated with a lithotomy towel. The operating cystoscope, with obturator in position and light tested, is lubricated with lubafax, passed into the bladder and clamped. The obturator is removed, the bladder emptied and washed out with boracic lotion (1 oz. to the pint) or oxycyanide of mercury 1 in 8000, the telescope inserted, and the viscus gradually distended by connecting the irrigator to the in-flow cock. The out-flow cock is connected to a bucket under the operating table by means of rubber tubing, and closed. The largest diathermy electrode is selected, passed down its sheath

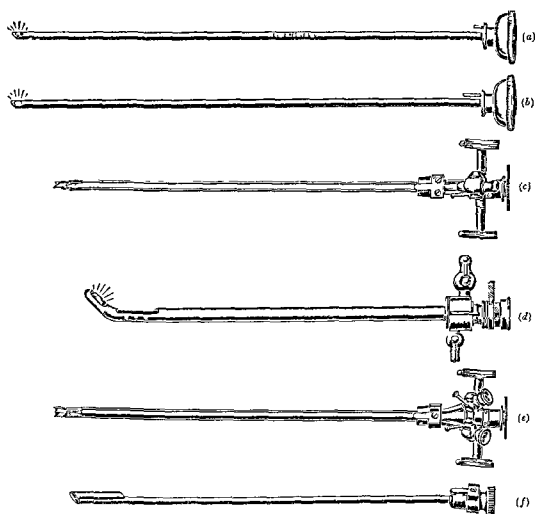


Fig. 1662. —WINSBURY-WHITE'S OPERATING AND CATHETERISING CYSTOSCOPE—COMPONENT PARTS —

- (a) Right angle telescope with large field
- (b) Retrograde telescope
- (c) Single catheterising attachment with special Albarran lever for retrograde diathermy work.
- (d) 24 Charrière sheath.
- (e) Double catheterising attachment.
- (f) Obturator.

and connected to the diathermy machine. The light cords are affixed and the light switched on. The surgeon, seated on a stool between the patient's thighs, removes the cystoscope from its clamp, and, after a brief survey of the bladder, applies the tip of the electrode to the growth. The current is turned on by the footswitch and treatment is continued until the whole surface has been coagulated. The terminal is next thrust right into the growth and an attempt made to destroy the deeper parts. In some cases it is possible to turn the growth on its side and apply diathermy to its pedicle. Continuous irrigation helps to keep the field of vision clear by washing away fragments of growth, hydrogen bubbles and blood, but it may be necessary to stop treatment at intervals and to withdraw the telescope in order to wash out the bladder through the sheath and clean the terminal.

Difficulties and complications are the same as those in the ambulatory treatment.

When the surgeon is satisfied that the growth has been destroyed, or that no more can be done at that sitting, the electrode and telescope are withdrawn, the bladder washed out until the return flow is clear and the cystoscope removed after inserting its obturator.

The patient is kept in bed for a few days, and alkalis and fluids are given until all discomfort on micturition has ceased. Hexamine and acids are then prescribed.

Cystoscopy should be carried out a month later and another similar treatment arranged for, or, if conditions have become favourable for ambulatory treatment, the latter is substituted.

If the growth is a borderline one, the cystoscopic appearances following the treatment are of extreme importance and may indicate its exact nature. Should malignancy be suspected, suprapubic excision must be carried out without delay.

(2) *Suprapubic route.*

Indications. (i) Malignant growths. (ii) Most borderline growths, especially when cystoscopic appearances following perurethral diathermy do not show a definite response to treatment. (iii) Growths complicating other conditions, such as enlarged prostate or stones. (iv) Growths complicated by cystitis or hæmaturia and clot retention, which do not respond to simpler measures. (v) Growths in patients with irritable bladders or those in whom instrumentation is followed by catheter fever or epididymitis.

In both innocent and malignant growths the danger of wound

implantation must be borne in mind during their removal. Thus excision should always be preceded by diathermy to the surface and pedicle of the growth, together with a small area of adjacent healthy mucous membrane.

(a) *Diathermy with or without excision of growth.*

The general preparation of the patient is as for cystotomy, but in addition the bladder is washed out daily for several days with silver nitrate 1 in 8000.

At operation, a leaden plate is placed under the buttocks and connected to the diathermy machine. A catheter is passed, the viscus distended with the solution previously used, and the bladder exposed by suprapubic cystotomy. Tractor sutures are inserted, and the viscus is emptied and incised, if necessary to one side of the mid-line, should the growth spring from the vault.

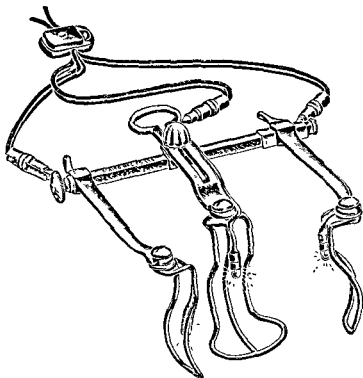


Fig. 1663.—MORSON'S SELF-RETAINING ILLUMINATED BLADDER RETRACTOR.

All innocent and many borderline growths spring from the vesical mucous membrane alone, and in such cases it is necessary to excise only a small area surrounding the pedicle.

The patient is placed in the Trendelenburg position and Morson's illuminated self-retaining retractor inserted (fig. 1663), further traction

sutures being passed through the edges of the bladder wound if necessary.

A straight or curved diathermy handle with a plate electrode suitable for the size of the growth (fig. 1664) is connected with the

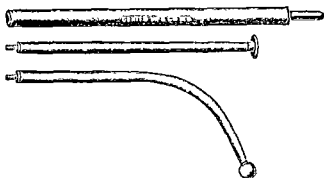


Fig 1664.—COAGULATION ELECTRODE COMPRISING BOILABLE INSULATED HANDLE AND STRAIGHT AND CURVED ELECTRODE CARRIERS WITH PLATE AND BALL ELECTRODES.

machine and the whole of the surface coagulated (fig. 1665). In some cases this may be all that is required, but in others the remainder of the growth is gently picked up with long forceps as near the base as possible and pulled away from the bladder wall, bringing with it a fold of mucous membrane. In the case of a borderline growth any fixation to the underlying muscular coat must be regarded with grave suspicion and its removal carried out by partial cystectomy. The fold of mucous membrane is cut through with the diathermy cutting current (fig. 1666), using a needle electrode mounted on an insulated handle

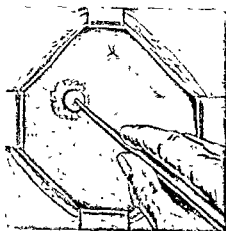


Fig. 1665.—OPEN DIATHERMY TO BLADDER GROWTH.



Fig 1666.—SUBTRAHALIC EXCISION OF INNOCENT PAPILLOMA BY DIATHERMIC NEEDLE.

(fig. 1667), and the growth removed from the bladder, care being taken that it does not touch the margins of the wound. If the growth is large, it is wise to protect the edges of the incision with swabs wrung out in 4 per cent silver nitrate solution to prevent implantation of a fragment of growth. Any bleeding points on the raw area are touched with the diathermy needle and the interior of the bladder swabbed out with the same solution. A drainage-tube is placed in the bladder, another smaller one in the prevesical space, and the wound is closed in layers.

Post-Operative Treatment. This is described under "Suprapubic Cystotomy."

After-Treatment. Cystoscopic examination should be carried out four times during the first year, twice during the second, and yearly for the rest of the patient's life.

Small recurrences are dealt with by perurethral diathermy.

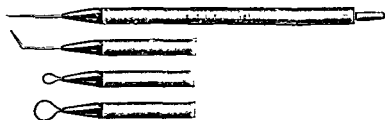


Fig. 1667.—CUTTING NEEDLES AND LOOPS.

(b) *Partial Cystectomy.*

The ease with which partial cystectomy for a malignant growth can be performed varies with its situation and extent, which will have been previously ascertained by cystoscopy.

Operation. The patient is prepared and anaesthetised as for cystotomy. A catheter is passed and the bladder washed out with silver nitrate 1 in 8000, distended with 10 oz. of this solution and exposed by suprapubic cystotomy. The prevesical fold of the peritoneum is retracted as far as possible, but may be adherent if a growth is present arising from the vault. Stripping is continued on the lateral aspect until the whole of the upper surface of the bladder is exposed. The wound edges are covered with swabs wrung out in 4 per cent silver nitrate solution, self-retaining retractors are inserted, and the recti muscles widely separated. Further procedures depend on the situation of the growth:

(i) *Growths on the vault of the bladder.* By palpation the situation of the growth is verified and traction sutures are inserted on each side

of it at a distance of $1\frac{1}{2}$ inches from its margin. The spigot is removed from the catheter and all the fluid allowed to escape.

An oval-shaped area including the growth is excised with the diathermy cutting current, or, failing this, a fine-pointed pair of scissors, care being taken to allow a one-inch margin of healthy surrounding bladder wall. As the incision is being made, further traction sutures are inserted. Any bleeding points in the cut surface are touched with the diathermy knife or picked up with forceps and ligatured, and the edges of the incision gently swabbed with gauze wrung out in 4 per cent silver nitrate.

The remainder of the bladder is explored and all blood and urine removed from its cavity. A Winsbury-White suprapubic tube is placed in the upper end of the bladder incision which is then closed and the abdominal wound sutured, as described under cystotomy, a small tube being inserted into the prevesical space.

If the prevesical fold of the peritoneum is adherent, the peritoneal cavity must be opened and the adherent area cut away, with immediate suture of the rent by a continuous catgut stitch.

After-Treatment. This is the same as for cystotomy, the prevesical tube being removed on the 4th day and the suprapubic tube about the 7th. The wound should be dry in from 14 to 21 days.

(ii) *Growths on the posterior wall of the bladder.* The bladder is mobilised as far as possible by stripping the peritoneum from its posterior and lateral walls (fig. 1668). If adherent, the peritoneal cavity must be opened, and that portion of the peritoneum which is attached to the bladder excised, with immediate suture of the rent by a continuous stitch. Two traction sutures are inserted into the bladder on either side of its middle line, the spigot is removed from the catheter, the fluid run out, and the patient placed in the full Trendelenburg position.

With sharp-pointed scissors the bladder is opened and the vesical aspect of the growth inspected. The incision is prolonged around the apex of the bladder until it approaches a distance of one inch from the growth. Additional traction sutures are inserted at intervals which allow the bladder to be drawn up into the wound. The growth is seared with the diathermy coagulating current, using large flat electrodes, or swabbed with 4 per cent silver nitrate solution.

An incision is next made with the diathermy cutting knife or scissors, encircling the growth at a distance of at least one inch from it. Sutures are inserted into the margins of the incision as the growth is resected. All bleeding points on the cut edge of the bladder are either seared

with the diathermy knife or picked up with long artery forceps and ligatured. A Winsbury-White suprapubic tube is inserted at the apex of the bladder and the incision sutured, both in front of and behind it. A small prevesical tube is introduced and the abdominal wound closed in layers.

(iii) *Growths arising from the bladder base.* As a rule growths in this situation are not amenable to partial resection, though occasionally the bladder wall, often with the lower end of one or other ureter, can be resected from within the bladder. The success of this procedure



Fig. 1668.—PARTIAL CYSTECTOMY. MOBILISATION OF BLADDER AND EXPOSURE OF LOWER END OF RIGHT URETER.

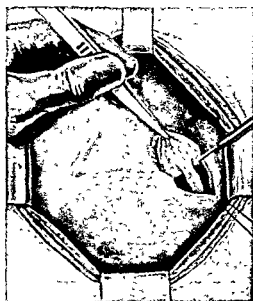


Fig. 1669.—PARTIAL CYSTECTOMY. EXCISION OF GROWTH ARISING NEAR URETERIC ORIFICE WITH ENTIRE THICKNESS OF BLADDER WALL.

depends on the mobilisation of the extravescical surface of the growth from the surrounding structures. Should this be found to be impossible, partial cystectomy must be abandoned. During this step in the procedure, the lower end of the ureter will be exposed and should be isolated from its surroundings (fig. 1668). Two traction sutures are inserted, one on either side of the mid-line of the bladder, the spigot removed from the catheter, the lotion allowed to escape, and the patient placed in the full Trendelenburg position.

The bladder is opened with pointed scissors, and Morson's self-retaining illuminated retractor inserted. After searing the growth with a large flat electrode, a circular incision is made around it, keeping at

least one inch away from its margin, through the entire thickness of the bladder wall, taking care not to injure the ureter (fig. 1669). As the incision is being made, traction sutures are inserted into the cut margin of the bladder. On withdrawing the growth together with its fringe of bladder wall, the ureter is put on the stretch and is defined by gentle gauze dissection. It is picked up with fine forceps and cut across between these and the growth (fig. 1669), and the latter, with its area of surrounding bladder wall, is completely removed. The lower end of the ureter is split for a quarter of an inch and a fine catgut stitch passed through one edge from within outwards and then through the bladder mucous membrane at the margin of

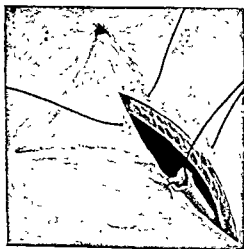


Fig. 1670.—PARTIAL CYSTECTOMY. LIPS OF URETER BEING STITCHED TO MARGINS OF BLADDER INCISION.

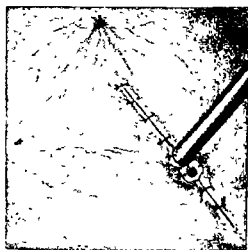


Fig. 1671.—PARTIAL CYSTECTOMY. URETER STITCHED IN POSITION. BLADDER INCISION CLOSED AROUND TUBE PASSED INTO PERI-VESECAL SPACE.

the incision (fig. 1670). The latter is then closed with interrupted sutures of fine catgut which pass through the entire thickness of the bladder wall, including the mucous membrane, a rubber drainage-tube having first been passed into the peri-vesical tissues between the ureter and the adjacent stitch. A second fine catgut stitch is inserted through the ureteric wall and passed through the mucous membrane on the side of the incision opposite that to which the ureter is already attached (fig. 1671). A Winsbury-White suprapubic tube is inserted into the apex of the bladder wound and the remainder, together with the abdominal wound, closed in layers, after inserting a small tube into the prevesical space.

After-Treatment. This resembles that following cystotomy. The prevesical tube is removed on the 4th day, the suprapubic on the 7th, and the peri-vesical tube on the 8th or 9th day.

(c) Total Cystectomy.

Total cystectomy is indicated for malignant disease of the bladder which cannot be removed by partial cystectomy, but which has not spread beyond its walls; if the prostate and vesicles are involved these must also be removed.

Preliminary Treatment. Cystectomy is a severe operation, and carries with it a high mortality. Careful inquiry must be made into the renal function and the degree of infection in the upper urinary tract, together with the patient's general condition. Preliminary suprapubic cystotomy may be necessary. When the patient's general and local condition is satisfactory the ureters are transplanted into the pelvic colon by Winsbury-White's two-stage method (see page 2877), and cystectomy delayed if possible until a month later.

Operation. The pre-operative preparation of the patient, the anaesthetic and the preliminary steps of the operation are similar to those for exposure of the prostate by Winsbury-White's perineal approach.

The rectum is separated from the membranous urethra and prostate until the seminal vesicles are exposed, and these are freed from the peritoneum lining the recto-vesical pouch, as high up as possible. Temporary dressings are applied and the patient's legs removed from the side irons. The bladder is exposed by a large median suprapubic incision, as described in the preliminary steps for suprapubic cystotomy, but without opening its cavity.

By gauze pressure the peritoneum is stripped away from the anterior aspect of the viscus until the urachus is reached, which is cut across. Stripping is continued along the lateral and posterior walls until the perineal wound is reached.

In parts the peritoneum may be adherent to the posterior wall of the bladder, in which case the peritoneal cavity is deliberately opened and the adherent portion excised. Any adhesions between the bladder and intestinal viscera must be gently separated and adherent omentum ligatured and divided.

The openings in the peritoneum are closed with continuous catgut sutures.

The bladder is next brought forward into the suprapubic wound and the seminal vesicles and vas deferens detached on either side. By pulling the viscus to one side the stump of the ureter and blood-vessels passing from the vesical neck to the lateral wall of the pelvis are exposed, caught up and ligatured, and the procedure repeated on the opposite side.

The spigot is removed from the catheter and the distending fluid allowed to flow out until the bladder is empty. The viscus is then seized with the fingers of the left hand and pulled backwards, producing tension on the pubo-vesical ligaments, which are cut across. After ensuring that the bladder neck is freed from its surroundings by blunt dissection, it is cut across at its junction with the prostatic urethra by means of a cautery and removed after dissection of the trigone from the prostate. All bleeding points are seized with artery forceps and tied off.

The suprapubic and perineal wounds are closed after inserting two large drainage-tubes into the depths of both wounds.

If extension of growth has occurred into the prostate, the latter must be removed together with the bladder. During the preliminary perineal operation and after separation of the rectum, the membranous urethra is cut across at its junction with the prostate, and the latter freed from the back of the symphysis pubis.

During the final steps of the suprapubic part of the operation, and after section of the pubo-vesical ligaments, the bladder and prostate will be found to be free.

Both wounds are closed, as has been described, with drainage to each. In the female sex a vaginal incision is made instead of a perineal.

FISTULA

A vesical fistula may open, into (1) the skin of the suprapubic region; (2) the vagina; (3) the intestine; or (4) the perineal region.

(1) *Suprapubic Vesical Fistula.* In rare cases this is congenital and due to a patent urachus. When acquired it is usually due to the performance of suprapubic cystotomy. The cystotomy wound may be permanent for the purpose of diverting the urinary stream in cases of incurable disease of the bladder, such as malignant prostate or intractable cystitis; it may be temporary, as between the first and second stages of prostatectomy; or fistulous from the occasional non-healing of the wound after prostatectomy. In the latter case it usually results from one of the following causes: (a) Continuance of lower urinary obstruction due to contraction of the prostatic cavity or to urethral stricture. (b) Development of phosphatic stones when infection is present and alkaline decomposition has occurred from insufficient bladder lavage and failure to keep the urine acid by suitable drugs. (c) Adhesions of the cystotomy wound to the back of the symphysis

pubis, which may result from placing of the cystotomy too near the pubis, and failure to push the bladder down into the depths of the pelvis during its performance. (d) Prolapse of the bladder mucous membrane through the wound. (e) Too long retention of a drainage-tube.

Treatment. A patent urachus, if present, should be excised. A persistent suprapubic fistula is dealt with according to the conditions found on routine examination and cystoscopy. A stricture or contraction of the bladder neck is treated by continuous dilatation with indwelling catheters and later by the intermittent passage of steel sounds or a Kollmann dilator.

Stones are removed and infection is dealt with by lavage and urinary disinfectants. Should these measures fail, the suprapubic track must be excised down to the bladder wall, and if necessary the anterior aspect of the bladder dissected free from the back of the symphysis pubis. In the presence of mild cystitis the wound may be closed in layers after tying in a large catheter, which is retained for ten days; but if much infection is present, the bladder should be drained suprapubically for a few days.

(2) *Vesico-Vaginal Fistula.* A fistulous communication between the bladder and vagina is usually the result of operations on the uterus, but may follow childbirth.

Symptoms and Signs. Incontinence of urine, with excoriation of the vulva and surrounding skin, develops shortly after operation or parturition. Cystitis is usually present.

Diagnosis. This is made by the history of a recent operation, the symptoms and signs, and cystoscopy. After drying the vulva and introducing a speculum, urine will be seen to escape from the anterior vaginal wall, and the finger will feel a localised thickening around the opening of the fistula. A bent probe can often be passed into the track.

Cystoscopic examination may be hampered by escape of the distending fluid into the vagina, but as a rule the vesical opening of the fistula, which is usually situated in some part of the trigone, can be seen. By manipulating the vaginal probe its point can often be made to project into the bladder, where it is visible (fig. 1672).



Fig. 1672.—VESICO-VAGINAL FISTULA; PROBE PASSED FROM VAGINA SEEN PROJECTING IN BLADDER.

Treatment. The successful cure of a vesico-vaginal fistula is difficult, and relapses after operation are frequent. Preliminary amelioration of the cystitis and vulvo-vaginitis by daily bladder wash-outs, vaginal douches, and urinary disinfectants is essential, and complications, such as vesical calculi, must be removed. This preliminary treatment should be maintained for some weeks and the improvement of the local conditions checked by regular bacteriological, cystoscopic, and vaginal examinations.

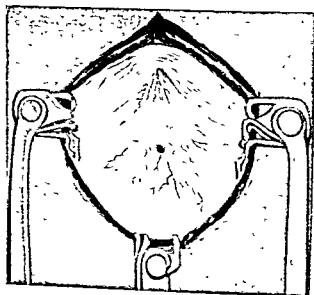


Fig. 1673.—MORSON'S SELF-RETAINING ILLUMINATED BLADDER TRACTORS IN POSITION. VIEW OF VESICO-VAGINAL FISTULA, VETERIC ORIFICES AND INTERNAL URINARY MEATUS.

Operation. The patient is prepared and anæsthetised, and suprapubic cystotomy performed, as described on page 2975. A full Trendelenburg position is adopted and Morson's illuminated self-retaining retractors are introduced (fig. 1673). The fistulous opening is seized with fine-toothed forceps and isolated, together with any surrounding thickening, from the normal bladder mucosa, by means of a transverse elliptical incision, which is deepened until the wall of the vagina is reached (fig. 1674A). The bladder is dissected free from the vagina for a distance of one inch both above and below the incision, and the fistulous track is excised (fig. 1674B).

The ureters are in front and outside the operation area, and run no risk of injury.

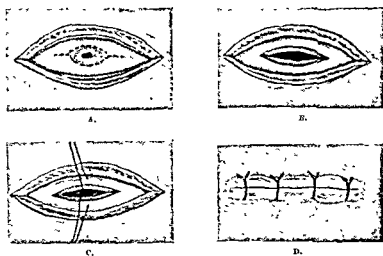


Fig. 1674 — EXCISION OF VESICO VAGINAL FISTULA.

Each lip of the incision in the vagina is transfixed with a stitch of No. 2 catgut, care being taken to ensure a good bite of the needle (fig. 1674C). The ends of each stitch are knotted together and pushed into the vagina (fig. 1675). The edges of the bladder incision are next united with a series of fine interrupted sutures of No. 0 plain catgut which are cut short (fig. 1674D).

A No. 40 Charrière Winsbury-White suprapubic tube is inserted into the upper end of the cystotomy wound, a smaller tube placed in the prevesical space and the wound closed in layers.

Dressings are applied and the patient is placed in the lithotomy position. By traction on the two stitches placed in the incision in the vaginal wall, the latter is rendered prominent and is closed by interrupted sutures of No. 0 20-day chromic catgut, after which the two

traction sutures are removed (fig. 1675). This operation may also be performed per vaginam, as described on page 2413.

After-Treatment. This is the same as for cystotomy, but not more than 2 oz. of lotion are introduced through the suprapubic tube at one time for the purpose of lavage. The prevesical tube is removed after four days and the bladder tube after ten, when the cystotomy wound is allowed to heal.



Fig. 1675.—EXCISION OF VESICO-VAGINAL FISTULA. SECTIONAL VIEW.

(3) *Vesico-Intestinal Fistula.* A vesico-intestinal fistula usually occurs between the bladder and the pelvic colon, and in the majority of cases is due either to diverticulitis or to malignant disease of the large bowel (fig. 1676).

In cases of vesico-colonic fistula due to cancer of the large gut, the best operative procedure consists of colostomy, whereby the intestinal contents are diverted, which results in marked diminution or even complete cessation of the cystitis.

In a non-malignant fistula an attempt may be made to close it, and this is best performed by a combined intra-vesical and intra-peritoneal operation. The peritoneal cavity is first opened and the bowel, together with any adherent omentum, separated as far as possible from the bladder. The bladder is next opened and a probe passed through the

fistula into the intestine. Dissection is then continued from the peritoneal aspect and the fistula cut across when the probe is reached. The openings in both bladder and bowel are closed by two layers of

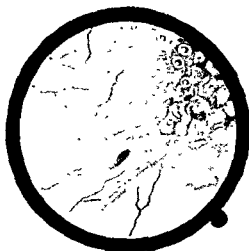


Fig. 1676.—VESICO INTESTINAL FISTULA.

sutures, but this may be extremely difficult owing to the amount of fibrosis present and the ready cutting out of the sutures. The peritoneal cavity and bladder are both closed with drainage.

CHRONIC CERVICITIS AND CERVICAL EROSION

Chronic infections of the cervix have been shown by Winsbury-White to be an important ætiological factor in inflammatory diseases of the female urinary tract, his conclusions being based on a series of animal experiments, which consisted in the injection of indian ink or

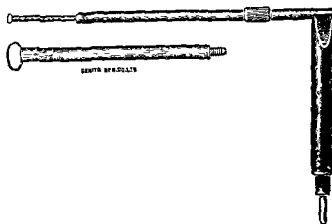


Fig. 1677.—DIATHERMY CUTTING CURRENT CUBETTE.
(*British Medical Journal*.)

tubercle bacilli into the cervices of rabbits, rats and guinea-pigs, and in killing the animals at times varying from one hour to three weeks later. Serial sections of the pelvic organs and soft parts of the posterior pelvic and abdominal walls were examined microscopically. Perivascular lymphatic spread was demonstrated both forwards to the submucous coat of the trigone of the bladder, and upwards to the kidney. The importance of eradicating cervical infection is thus emphasised as a preliminary to any direct treatment of the urinary tract.

The following operation is an attempt to remove the cervical glands completely with the minimum of mutilation. In principle it consists in

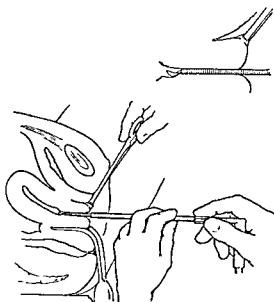


Fig. 1678.—METHOD OF USING THE CERVICAL CUTTING CURRENT CURETTE.

(*British Medical Journal*.)

the removal of longitudinal strips of the endocervix by means of the diathermy cutting current curette (fig. 1677), which is a fine tungsten wire loop, elliptical in shape and fixed at an angle of 30 degrees at one end of a well-insulated metal rod. The other end of this rod is threaded, and screws into a larger rod about four and a half inches long, which engages in a socket fixed at a right angle on an insulated handle in such a way that it can rotate but not disengage without a strong pull. The insulation of the rod is increased near the handle to form a collar, serrated at the circumference, by which it can easily be rotated with the thumb and index finger of the right hand. The cable from the cutting diathermy machine plugs on to the pin at the lower end of the handle.

The patient, who should arrange to stay in a hospital or nursing home for a week, is anaesthetised and placed in the lithotomy position. A lead belt surrounding the waist is connected to the diathermy machine and constitutes the indifferent electrode. The skin and vagina are painted with surgical dettol, which is non-inflammable, towels are adjusted, a speculum is inserted, and the cervix is grasped laterally with vulsellum forceps and pulled forward. The uterine cavity is explored with a sound, the cervical canal dilated to No. 8 Hegar (25 degrees Charrière), and dried as far as possible with gauze.

The strength of the current is adjusted (dial setting 4 on the genito-urinary endo-diathermy machine), and the curette passed a quarter of an inch beyond the internal os (fig. 1678). The current is then turned on with the footswitch, and a strip of pars intermedia and cervix removed from the roof of the canal, the instrument being steadied with the fingers of the left hand. Great care must be taken not to allow the cutting loop to slip as it leaves the external os, and to remember at this point to turn off the current with the footswitch; also to hold the stem of the curette parallel with the cervical canal in order not to cut too deeply. The loop is so constructed that strips of lining membrane and underlying glands are removed in one piece if the instrument is correctly held. If for any reason it is necessary to make a deeper cut, *the instrument can be tilted and tissue up to one-quarter of an inch in depth cut out*. Strips are then cut from the sides, and lastly from the floor. As each cut is made, bleeding automatically stops from this area, until finally the endocervix is completely dry, which enables the operator to gain a perfect view and to deal with any small part which may have escaped resection. If an erosion is present it is excised by a larger cutting loop mounted on a bakelite handle, and the uterine cavity and cervical canal packed with gauze plugging soaked in 10 per cent picric acid in absolute alcohol, which is removed eight hours later. The operation is completed by dilating up the urethra with a special pair of urethral forceps to 40 degrees Charrière in order to deal with the associated urethritis.

Saline douches are begun seven days later, and continued until the cervix is healed, which takes about two months. Intermittent dilatations of the urethra at fortnightly intervals are continued until a calibre of 40 degrees Charrière is attained without bleeding and without any appreciable resistance.

Figures. 1679, 1680 and 1681 show a case of chronic cervicitis with an extensive erosion before treatment, directly after treatment, and three months after treatment. The results of this method of operative

treatment for chronic cervicitis, especially if it has given rise to renal or vesical symptoms, are excellent, both clinically and pathologically.

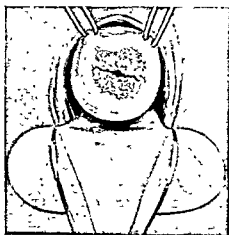


Fig. 1679.—CHRONIC CERVICITIS AND CERVICAL EROSION.

(*British Medical Journal.*)

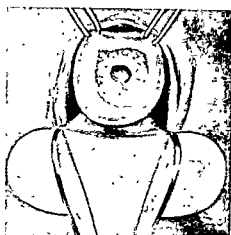


Fig. 1680.—APPEARANCES OF CERVIX AFTER DIATHERMY WITH CUTTING CURRENT CURETTE.

(*British Medical Journal.*)

Clinically, vaginal discharge, frequency, dysuria, renal pain, and backache disappear in the absence of any other gynæcological or urological cause, and there is no distortion or contraction of the cervical

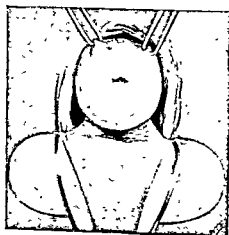


Fig. 1681.—APPEARANCE OF CERVIX THREE MONTHS AFTER OPERATION.

(*British Medical Journal*)

canal. This is only to be expected, as excision of tissue by the diathermy cutting current is followed by a supple scar which does not contract, and so resembles the results obtained in other parts of the body.

Pathologically, a series of hysterectomies was performed ; in some cases immediately following diathermy curettage, and in others six months later. Serial sections of the cervix showed that in the former all the infected tissues had been removed, and that in the latter there were no signs of cervicitis.

CHAPTER V

DISEASES OF THE PROSTATE GLAND AND SEMINAL VESICLES

ACUTE PROSTATITIS

ACUTE prostatitis is always due to bacterial invasion, usually by the gonococcus, secondary to a posterior urethritis, but sometimes by the *B. coli*, staphylococcus, streptococcus, or *B. proteus*. It may occur spontaneously or follow the passage of an instrument. Occasionally an abscess results which may rupture into the urethra or may have to be opened by the perineal route.

Symptoms and Signs. In mild cases there is frequency and difficulty of micturition, some dysuria, and a feeling of weight in the perineum.

In severe cases frequency and perineal pain are extreme. Micturition and defæcation are very painful, and agonising erections may occur.

As the prostate increases in size, difficulty becomes more marked, until (especially in cases of abscess) there is complete retention. Urethral discharge, as a rule, diminishes or ceases, and the temperature is raised to 103° or 104° F., occasionally with rigors.

On rectal examination the prostate is exquisitely tender and tense, unless an abscess has formed, when a fluctuating area will be felt which can sometimes be ruptured into the urethra by pressure of the examining finger.

Treatment. The patient should be ordered sitz baths, and be put to bed with hot bottles to the perineum and suprapubic region. All local irrigation and instrumentation are stopped, except in cases of retention which may be due to abscess formation, when a soft rubber catheter must be passed under local anæsthesia three or four times a day and the bladder washed out with acriflavine, 1 in 8000. The prostate is examined per rectum daily and, should an abscess be felt, gentle massage or the passage of the catheter may cause it to rupture into the urethra. Fluids and alkalis are given by mouth, and hot rectal irrigations, followed by a suppository of morphia $\frac{1}{4}$ gr., administered morning

and evening. A purge is essential, and the bowels must be moved regularly with salines. The diet should be light.

In most cases the acute symptoms gradually subside and the treatment becomes that of chronic prostatitis; but should they increase, as shown by rigors, rising temperature, and an exaggeration of the local symptoms, the prostate must be drained without delay.

Operation. The swollen prostate is exposed by the perineal route (see page 3001), a small incision made into it with a scalpel, and the cavity dilated with artery forceps until pus is found. A drainage-tube is inserted and the abscess cavity irrigated daily. As healing takes place, the tube is gradually shortened, care being taken that no pocketing occurs.

ACUTE SEMINAL VESICULITIS

Acute seminal vesiculitis is invariably associated with an acute prostatitis. It is characterised by an intensely painful distended vesicle which can be felt per rectum beyond the swollen prostate.

The treatment is that of acute prostatitis.

CHRONIC PROSTATITIS AND VESICULITIS

Chronic prostatitis may follow an acute attack or be secondary to chronic posterior urethritis, but in a definite number of cases no cause can be found for its origin. It is a disease with far-reaching consequences, and must always be considered during the investigation and treatment of chronic urinary tract infections.

The infection may spread to the remainder of the *genital tract* causing seminal vesiculitis and epididymitis, to the *urinary tract* causing cystitis, pyelitis, pyelonephritis and hydronephrosis, or to *distant parts* causing chronic arthritis, synovitis and fibrositis. Patients often complain of these secondary affections, and in a number of cases the existence of a chronic prostatitis is overlooked or its significance ignored. As the result of chronic fibrosis, gradual stenosis of the bladder neck may occur with advancing years, with production of all the symptoms of prostatic obstruction, but without enlargement of the gland, the "prostatisme sans prostate" of the French. In some cases, prostatic calculi are formed.

Symptoms and Signs. Pain may be absent or may be referred to the lumbar region, sacro-iliac joints, rectum, perineum, urethra, groins, or

In gonococcal cases rectal diathermy is a useful adjunct to treatment. It is applied through a special rectal electrode (fig. 1683), fitted

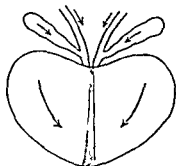


Fig 1682.—METHOD OF
MASSAGING PROSTATIC GLAND.
(After Kenneth Walker)

with a thermometer, and the temperature gradually raised to 110° F. Treatment is given twice weekly and is followed by massage and irrigation.

In cases complicated by metastatic lesions such as fibrositis, an autogenous vaccine may be tried. Massage, however, by causing absorption of toxin into the blood stream acts in much the same way and is usually more effective.



Fig 1683.—RECTAL DIATHERMY ELECTRODE.

- P. Prostatic plate.
- C. Collar.
- S. Thumb-screw.
- T. Thermometer

Occasionally a vesicle filled with pus cannot be emptied by the foregoing methods, owing to blocking of its duct; in such cases an attempt must be made to wash it out. This can be done by catheterising the ejaculatory duct through a posterior urethroscope, a procedure which may be simple or difficult. When, as often, it proves impossible, the vas has to be exposed by an incision in the upper part of the scrotum—*rasotomy* (see page 2977)—and 5 to 10 cc. of 5 per cent neoreargon injected into it.

In extreme cases the vesicles must be drained or excised by the perineal route.

Operation. The first steps of the operation are in many ways similar to those of perineal prostatectomy. The prostate is pulled well

thighs. It is usually of a dull aching character, but sharp exacerbations may occur.

Urinary. There is usually some frequency and terminal dysuria, and often signs of chronic posterior urethritis, such as turbidity of both specimens when urine is passed into two glasses.

Genital. There may be painful erections, premature ejaculations, and nocturnal emissions. If vesiculitis is present there may be pain after coitus and also hæmospermia, the blood being intimately mixed with the semen. Epididymitis may occur.

Metastatic. Chronic arthritis, synovitis, and fibrositis are not uncommon.

Diagnosis. Some gleet discharge can frequently be expressed from the urethra and may be noticed on defæcation. The external genitals often show some degree of thickening of one or both epididymes.

Rectal examination reveals rather an irregular prostate, which may be smaller or larger than normal. Massage gives rise to a tenderness and to a characteristic pain referred to the tip of the penis, and the prostatic secretion contains pus cells and organisms.

The posterior urethra shows chronic inflammation when viewed through a posterior urethroscope, and the verumontanum is often enlarged and papillomatous (see fig. 1503).

The urine may be normal, but usually contains flakes which on microscopic examination are seen to contain pus and organisms.

Treatment. This is usually protracted and requires the full co-operation of the patient. The urethritis must be treated daily with complete irrigations of acriflavine, 1 in 8000, while the urine is cloudy, and oxycyanide of mercury, 1 in 8000, when it is clear. All sexual excitement and violent exercise should be forbidden, the bowels regulated, simple food encouraged, and a holiday advised. Prostatic and vesicular massage are carried out twice weekly and the bladder neck stretched up every ten days (under local anæsthesia) with Kollmann's posterior dilator, which acts as a kind of internal massage (see page 3077). Massage, to be effective, must be correctly performed, the contents of the vesicles and prostate being emptied by pressure in the direction of their ducts as shown in figure 1682. Both massage and dilatation are followed by a complete irrigation.

In gonococcal cases rectal diathermy is a useful adjunct to treatment. It is applied through a special rectal electrode (fig. 1683), fitted

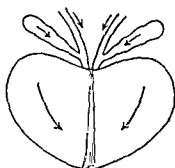


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In extreme cases the vesicles must be drained or excised by the perineal route.

Operation. The first steps of the operation are in many ways similar to those of perineal prostatectomy. The prostate is pulled well

down with a prostatic tractor until the vesicles come into view, when they are dissected free from their surroundings. They are drained or excised as conditions suggest, and the prostate is carefully palpated, and incised if necessary. A drainage-tube is inserted and the wound irrigated daily. As healing occurs, the tube is shortened and finally removed.

TUBERCULOSIS OF THE PROSTATE

Tuberculous prostatitis is usually seen in young adults, and may follow a previous gonococcal inflammation of the gland. It may be associated with renal tuberculosis, but this relationship is inconstant and not clearly understood; if co-existing, however, there is some evidence to show that the focus in the prostate is primary as far as the genito-urinary tract is concerned, and that the kidney is involved secondarily by upward lymphatic spread.

The periphery of the gland is usually the first part to be affected, soft caseating areas being formed by coalescence of tubercles which may burst into the urethra, bladder, rectum, or vagina.

The disease gradually extends to the prostatic urethra and bladder neck, to one or both seminal vesicles, and from thence via the vas to one or both epididymes.

Symptoms and Signs. While confined to the prostate, tuberculosis of the gland may not give rise to any symptoms, with the exception of some degree of dull perineal discomfort.

When the posterior urethra and bladder neck become involved there is increasing frequency, difficulty, and pain which consists of terminal dysuria and an aching and burning in the perineum and anus.

Blood-stained seminal emissions may occur, and the urine at the end of micturition contain a few drops of blood. Urethral discharge is rare.

The urine is acid, contains pus, and may contain the tubercle bacillus. Tuberculous epididymitis or renal tuberculosis may be present.

Diagnosis. This is made by a consideration of the symptoms and a routine examination. Tuberculous epididymitis and beading of the vas may be present, and evidence of the disease in other parts of the body be found.

Rectal examination usually reveals slight enlargement of the prostate, which is tender and has a nodular feel. The nodules vary in consistency, are small, and are more prominent and circumscribed

than in carcinoma of the gland. Thickening of one or both seminal vesicles may be present, and occasionally the vas can be palpated as a hard irregular cord.

In the later stages, when abscess formation has occurred, a tender fluctuating swelling will be felt.

Unless secondary infection has occurred, the urine is acid and contains pus. In some cases the tubercle bacillus can be identified.

Treatment. Tuberculous prostatitis may be latent and only be discovered during a routine examination, or it may remain stationary for years. Usually, however, it is steadily progressive. Radical measures and all forms of local injections into the posterior urethra and instrumentations are contra-indicated. General constitutional measures should be adopted and several courses of vaccine treatment given, using tuberculin T.R. as described under "Tuberculous Epididymitis" (see page 3048).

Renal tuberculosis and secondary epididymitis, if present, must receive treatment.

A prostatic abscess should be opened and well scraped by the perineal route, and iodoform emulsion injected into its cavity. A fistula is only too common a sequel and when present must be thoroughly curetted.

Extreme involvement of the bladder may require permanent suprapubic cystotomy.

PROSTATIC CALCULI

Prostatic calculi are small oval bodies and are formed round the corpora amylacea in the acini of the gland by the deposition of phosphate, oxalate and carbonate of calcium. They are frequently found in the prostates of old men, are usually multiple, and are almost invariably the result of chronic prostatitis. Occasionally a large solitary stone occurs in younger men which may be the sequel of an old prostatic abscess. As the calculi enlarge, they tend to work their way along the prostatic ducts which become dilated. These stones may be passed per urethram. Suppuration often occurs around the embedded stones, giving rise to multiple prostatic abscesses which may burst into the urethra or open into the perineum.

Symptoms and Signs. If deeply embedded in the prostate, there may be no symptoms whatsoever, the calculi being found at post-mortem or during the course of a routine X-ray examination.

Symptoms of chronic prostatitis are, however, usually present and, in addition, gradually increasing dysuria and sometimes retention if the stones are situated in the median lobe.

Diagnosis. This is made by a consideration of the symptoms and a routine examination. Rectal examination may fail to detect more than a chronic prostatitis if the calculi are near the urethra, but more frequently several stony hard nodules, sometimes grating on massage, will be felt. Grating may also be noticed during the passage of a sound,

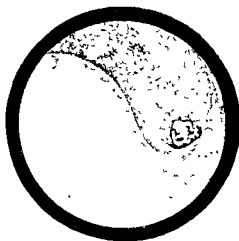


Fig. 1684.—STONE PROJECTING FROM A DILATED PROSTATIC DUCT. URETHROSCOPIC VIEW.

and dilated prostatic ducts oozing pus, or even stones, may be seen through the posterior urethroscope (fig. 1684). Chronic trigonitis and posterior urethritis are present and the urine is usually cloudy with pus. An X-ray examination will confirm the diagnosis.

Treatment. Prostatic calculi, even if discovered accidentally, always call for treatment because of the associated chronic prostatitis which is progressive and will sooner or later produce symptoms. Such treatment may be carried out by instrumental or operative means.

- (a) *Instrumental.* This is indicated when a stone or stones can be seen with a posterior urethroscope to be lying in the mouth of a dilated prostatic duct, and X-ray examination shows that the remainder of the gland is free from calculi.

The preparation of the patient, equipment, anaesthesia and position are as for perurethral resection of the prostate. An operating urethroscope, such as Canny Ryall's, and cystoscopic forceps are required.

Technique. The operating urethroscope is passed, the bladder washed out, and the telescope inserted. The posterior urethra is carefully examined, the stone located, and an attempt made to extract it with the cystoscopic forceps. If the stone is tightly embedded in the prostate it can often be freed by incising the gland with the diathermy cutting current applied through an insulated wire electrode, similar to the one which is used for slitting up a ureteric orifice, or by using McCarthy's loop electrotome. Another attempt is then made to extract the calculus with forceps, either at the same time or at a subsequent date.

In case of failure, operative measures must be adopted.

(b) *Operative.* This is indicated when the calculi are multiple, or when instrumental means have failed.

Operation. This is performed in the same way as a suprapubic prostatectomy, and the same precautions are taken as to preliminary treatment. An attempt is made to enucleate the gland, but as prostatic calculi are the sequel of chronic prostatitis, fibrosis is the rule, often with much shrinkage of the gland, and the stones will have to be removed with a sharp spoon.

After-treatment must be directed to the cure of the infection present, and to the prevention of bladder-neck obstruction by intermittent dilatation, and sometimes by perurethral resection.

PROSTATIC OBSTRUCTION

Under this heading will be described two conditions having an entirely different pathology, but which give rise to similar symptoms and signs and produce similar effects on the proximal parts of the urinary tract. These conditions are: (a) Prostatic Enlargement, and (b) Prostatic Fibrosis.

Pathology. Enlargement of the prostate, according to Kenneth Walker, is in the nature of a fibro-epithelial degeneration, comparable to the change which occurs in the female breast at the menopause. Nothing definite is known of its causation, and it is not considered to be secondary to previous inflammations of the gland.

Fibrosis of the prostate is usually the sequel of past inflammatory disease, and is comparable to the formation of a urethral stricture resulting from prolonged chronic urethritis. This fibrous obstruction

at the bladder neck is commoner than is usually supposed, constituting at least one third of the total cases of prostatic obstruction.

Effects of Prostatic Obstruction. (1) *Urethra and Bladder.* As the prostate enlarges, it follows the line of least resistance and may extend backwards into the rectum where it can be felt with the finger, upwards into the bladder, or in both directions. In its upward spread it makes its way through the internal sphincter muscle carrying with it the posterior urethra which becomes elongated and, if the enlargement is irregular, distorted. At the same time the level of the internal meatus becomes raised, the intravesical projection of the prostate varying according to the lobe or lobes affected and to the amount of the enlargement. Such projections are described as generalised, lateral lobe, median lobe or collar, according to the appearances found at cystoscopic examination.

A retro-prostatic pouch gradually forms, which cannot empty itself during micturition, and it is the amount of this residual urine which constitutes an important sign of the disease. Alkaline decomposition may occur and secondary phosphatic stones be formed.

At first the bladder wall hypertrophies, to enable it to meet the increasing difficulty of expelling its contained urine, but later, especially in elderly men, compensation breaks down, and dilatation occurs, often with the formation of diverticula consisting of hernia-like protrusions of mucous membrane between the thickened muscular bundles (figs. 1685 and 1686). The capacity of the organ may gradually increase to several pints until chronic distension with overflow supervenes.

(2) *Ureters and Kidneys.* After a short period of muscular hypertrophy, back pressure causes dilatation and pouching of the ureters from thinning and atrophy of their walls. At the same time they increase in length and become tortuous. Dilatation of the renal pelves with interstitial fibrosis of the secreting tissue gradually occurs with hollowing out of the calyces, formation of hydronephroses of the renal type, and increasing renal insufficiency.

(3) *Inflammatory.* At some time in the progress of the disease cystitis occurs, either spontaneously, following the passage of a catheter, or from exposure to cold or wet. Stone formation is further encouraged, acute retention from prostatic congestion may occur, and spread of infection upwards with consequent ureteritis, pyelitis and pyelonephritis becomes inevitable.

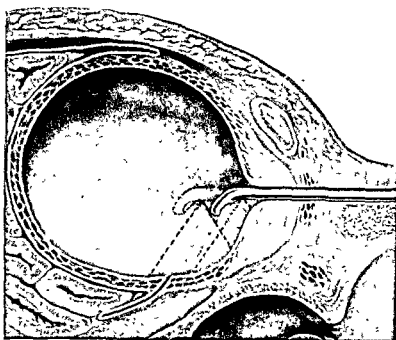


Fig. 1685.—SAGITTAL SECTION OF NORMAL BLADDER, SHOWING THAT MEDIAN LOBE AND URETERIC ORIFICE CANNOT BE SEEN IN SAME CYSTOSCOPIC FIELD.

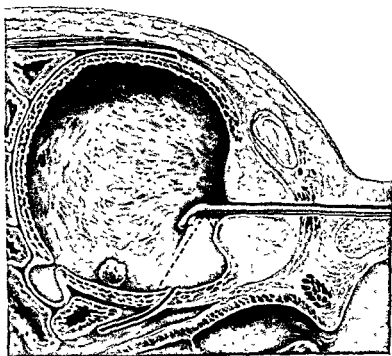


Fig. 1686.—RESULTS OF PROSTATIC OBSTRUCTION, SHOWING TRABECULATED BLADDER, VESICAL CALCULUS, FALSE DIVERTICULUM AND INTRAVESICAL PROJECTION OF MEDIAN LOBE OF PROSTATE, WHICH CAN BE SEEN IN SAME FIELD AS URETERIC ORIFICE.

(4) *Circulatory.* Hyperæmia of the prostatic mucous membrane is common, often with dilatation and varicosity of the veins, which may rupture and cause hæmaturia.

Symptoms and Signs. These are usually insidious in onset. They are most commonly referable to the act of micturition, but at times general symptoms of renal insufficiency, such as sleeplessness, thirst, poor appetite, headache, etc., may cause the patient to consult a doctor. Only a routine urological examination will reveal the true state of affairs.

Frequency. This is one of the earliest symptoms and occurs in the absence of residual urine or cystitis. Wilson believes that it is due to slight eversion of the very sensitive mucous membrane of the prostatic urethra into the bladder, due to the upward enlargement of the prostate and its unaccustomed exposure to the accumulating urine. The frequency is noticed at first during the night, usually in the early hours of the morning, and later by day. It gradually increases, especially after the occurrence of residual urine, cystitis or stone.

Hæmaturia. This may occur from prostatic congestion and is at first terminal. If due to a ruptured vein it may be profuse. It is commoner with an innocent than a malignant gland, and in the presence of complications such as cystitis or stone.

Pain. There is often a feeling of weight in the perineum and some sacral aching. Dysuria is only marked if cystitis or stone is present, or if acute retention has occurred.

Turbidity. This indicates the presence of cystitis or, if clearing with acid, of phosphaturia due to alkaline decomposition.

Stream. This becomes progressively smaller, and the force of projection diminishes until it may eventually become a dribble.

Difficulty. This is one of the chief characteristics of the disease. Even when the desire to micturate is great, there may be a delay of several seconds or even minutes before the act can be started. Straining definitely hinders the process. This factor helps to exclude a diagnosis of urethral stricture, in which straining assists the act of micturition.

Retention. In some rare cases this may be the first symptom and may be *partial*, the patient being able to pass water although the

amount of residual urine after the act is much greater than usual, or *complete*, when no urine can be passed at all. Retention usually follows an indiscretion, such as over-exercise, over-eating, exposure to wet and cold, or to enforced holding of water.

Incontinence. This, if present, is really retention with overflow, the bladder on palpation sometimes reaching as high as the umbilicus.

Disorders of Sexual Function. These consist of increased sexual desire and a diminished power of gratifying it. In addition, there frequently exists some degree of moral perversion.

Diagnosis. This is made by a consideration of the history, the symptoms, and by routine examination and cystoscopy. The external genitals may be normal, or some thickening of the epididymes suggest a chronic genital infection.

Rectal examination, although of the greatest importance, must be regarded as only one link in the chain which leads to the correct diagnosis. In most generalised enlargements, the prostate will be felt to occupy a much greater area than normal, with bulging into the rectum. The natural outlines are preserved, the median groove is present, there is no irregularity or area of hardness, and the rectal wall can be made to slide over it.

In carcinoma, however, the prostate is stony hard, and irregular nodules are felt. The median groove may be obliterated and the gland is fixed. Lymphatic invasion to the lateral sides may be felt as diffuse thickenings and sometimes as hard nodules, and the rectal wall may be adherent.

In median lobe enlargements the prostate may feel normal, whereas in fibrous contraction it is smaller and harder.

The gland is massaged and the patient directed to empty his bladder into two glasses. The act will be seen to be characterised by difficulty in starting, a small stream with little force of projection, and hindered by straining. The second specimen of urine, which is clear or turbid according to whether cystitis is present or not, should be examined for albumen, phosphates and sugar. If turbidity is present which does not clear with heat or acid, the specimen should be sent for bacteriological examination to determine the nature of the infection and the presence of any abnormal constituents.

Catheterisation and the estimation of the residual urine is another most important step in the diagnosis. The urethra is anæsthetised and

an attempt made to pass a No. 12 E. coudé catheter which will exclude the presence of a stricture. As a rule little difficulty is experienced in its passage, but in cases of marked median lobe enlargement the catheter will be obstructed, when a bicoudé of similar size should be used. During the introduction of the cocaine solution a general and abdominal examination should be carried out which must include the reaction of the pupils to light and accommodation in order to exclude tabes; signs of renal failure such as dry glazed tongue, harsh and dry skin, earthy complexion, emaciation and a drawn and sallow face; tenderness over the renal areas; and in particular, careful examination of the bladder area. If the viscus is much enlarged, not more than 15 oz. should be withdrawn and the patient treated as for chronic retention (see page 2968), all subsequent examinations being delayed for some days until the bladder is empty. If no enlargement can be detected suprapubically, the bladder should be emptied and the amount of residual urine noted.

Cystoscopy and Chromo-cystoscopy. These examinations may be carried out instead of catheterisation if the patient is moderately well, or deferred to a later date if he is ill or is suffering from chronic retention, when definite precautions must be taken. These latter consist of rest in bed and tying in a catheter in cases of chronic retention, and the exhibition of alkalis and fluids for several days after the bladder has been decompressed.

In ordinary cases the examination should be preceded for three days by hexamine 10 grs. before meals and an acid mixture after.

Cystoscopy is of the utmost importance as it will give information regarding the intravesical enlargement of the prostate, and will establish the presence of complications, such as stone, growth, diverticula, etc., which call for a two-stage operation. When combined with the intravenous injection of indigo-carmin it will provide an estimate of the renal function and determine whether preliminary drainage is necessary, either by catheter or cystotomy or both.

When the urethra has been cocainised, a cystoscope is passed in the ordinary way, after emptying the bladder, and any residual urine is measured and if necessary sent for examination. As in catheterisation, some difficulty may be encountered in surmounting a much enlarged median lobe, and the cystoscope will often have to be depressed well below the horizontal. In cases of distortion of the posterior urethra, due to irregular enlargement of the lobes, lateral movements may allow the beak of the cystoscope to traverse the deviated canal. Fibrous contraction of the bladder neck may also cause some obstruction

and may necessitate the preliminary passage of a curved steel sound. Extreme gentleness is of the utmost importance during the whole procedure, as hæmorrhage from the congested prostate is very likely to occur and may obscure the cystoscopic view.

In the presence of marked cystitis much irrigation through the cystoscope will be necessary before the return flow is clear. If hæmorrhage has occurred either before or as a result of the cystoscopy, and the view is obscured, adrenalin should be injected and allowed to remain in the bladder for a few minutes, before irrigation is continued.

Cystoscopic appearances. (a) *Prostate.* For cystoscopic purposes the intravesical projection of the prostate is divided into two lateral lobes and one median lobe. In the normal state the edges of the lateral

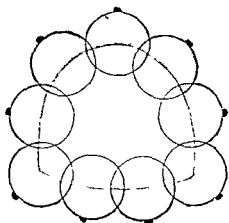


Fig. 1687.—COMPOSITE DIAGRAM OF NORMAL BLADDER NECK, MADE UP BY NINE CYSTOSCOPIC FIELDS.

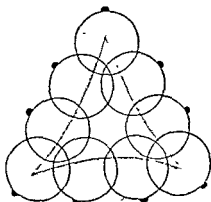


Fig. 1688.—COMPOSITE DIAGRAM OF BLADDER NECK SHOWING GENERALISED INTRAVESICAL ENLARGEMENT OF PROSTATE, AS SEEN THROUGH NINE CYSTOSCOPIC FIELDS.

lobes show a marked concavity, and those of the median lobe a slight one, when viewed with a cystoscope which has been withdrawn into zone A (see page 2723). Approximately one-ninth of the bladder neck can be seen in one cystoscopic field, and the accompanying figure is a composite one of the normal condition made up of nine overlapping cystoscopic fields, the indicator showing the direction of view (fig. 1687). A composite diagram of the bladder neck is also shown (fig. 1688) in the presence of a generalised enlargement of all three lobes, which shows a convexity of all its margins. At 12 o'clock the two lateral lobes will be seen meeting at an acute angle or inverted V (fig. 1689). The same can be seen at the junction of the lateral and median lobes at 4 and 8 o'clock.

The prostatic margin does not always present a smooth appearance, and many varying shapes may be seen between the normal and the generally enlarged gland depending on the number and size of the individual adenomatous projections. It is of the utmost importance to decide which lobe or lobes are enlarged, as prostatectomy is always indicated if all three lobes are affected, while many of the pure median hypertrophies and most of the fibrous prostates should be dealt with by perurethral resection.

(b) *Bladder.* (1) *Retro-prostatic Pouch.* In normal cases, when the cystoscope is gradually pushed into the bladder, the whole of the neck from the margin of the median lobe to the inter-ureteric bar can



Fig. 1689.—INTRAVESICAL ENLARGEMENT OF PROSTATE, JUNCTION OF LATERAL LOBES. CYSTOSCOPIC VIEW.



Fig. 1690.—ENLARGED MEDIAN PROSTATIC LOBE AND LEFT URETERIC ORIFICE, SEEN IN SAME FIELD. CYSTOSCOPIC VIEW.

be seen gradually shelving its way downwards, and at 4 or 8 o'clock the prostate and ureteric orifice cannot be seen in the same cystoscopic field (see fig. 1685). As the median lobe enlarges intravesically, this gradual slope becomes steeper and steeper until, even with early cases, the prostatic edge can be seen in the same field as the ureteric orifice (figs. 1686 and 1690) and the inter-ureteric bar (fig. 1691). Further enlargement causes an actual overhang of the prostatic rim with formation of a retro-prostatic pouch, and part of the trigone and eventually even the ureteric orifice may become obscured from view. Residual urine increases in direct proportion with the size of this recess. In some cases the median lobe forms a finger-like projection, acting as a kind of ball-valve, which closes during micturition. This causes the amount of residual urine to increase out of all proportion to the actual size of

the enlargement, with rapidly increasing damage to the kidneys by back pressure. Such prostates may often feel perfectly normal per rectum and cause no obstruction to cystoscopy or catheterisation.

(2) *Hypertrophy*. This is seen with all chronic types of obstruction to micturition, such as prostatic hypertrophy or fibrosis, urethral stricture, or pin-hole meatus. Instead of the normal smooth appearance of the vesical mucosa, hypertrophied bands or trabeculæ of muscular tissue covered by mucous membrane are seen running in all directions, resembling the chordæ tendineæ of the ventricles of the heart (see figs. 1617 and 1686).

(3) *Diverticula*. False diverticula are common and consist of hernial protrusions of mucous membrane between adjacent bundles of hyper-

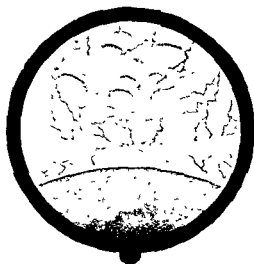


Fig. 1681.—INTRAVESICAL PROJECTION OF PROSTATE
MEDIAN LOBE AND INTER URETERIC BAR SEEN IN
SAME CYSTOSCOPIC FIELD.

trophied muscular fibres. A true diverticulum, the wall of which is formed of all the same constituents as that of the bladder, though uncommon, is more frequently seen in prostatics than in others, which suggests that obstruction plays at least a part in its ætiology (see fig. 1686).

(4) *Dilatation*. This occurs when compensation breaks down and is the eventual sequel of hypertrophy. It is shown by a large amount of residual urine and often by the enormous tolerance of the bladder to distension.

(5) *Cystitis*. Some hyperæmia, especially in the region of the neck, is usual, and the remainder of the bladder is often injected.

When infection is present, the changes resemble those of cystitis.

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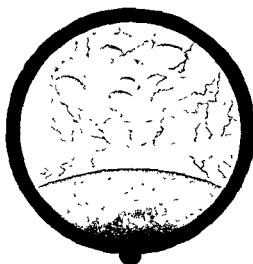


Fig. 1691.—INTRAVESICAL PROJECTION OF PROSTATE
MEDIAN LOBE AND INTER-LOBAR BAR SEEN IN
SAME CYSTOSCOPIC FIELD.

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THE TREATMENT OF PROSTATIC OBSTRUCTION

(A) GENERAL PRINCIPLES

URINARY obstruction due to prostatic hypertrophy probably constitutes the most important of all urological conditions owing to its devastating effects on the whole urinary tract proximal to the internal urinary meatus. Back pressure, infection, or a combination of the two, causes gradually increasing and sometimes irreparable damage to the kidneys with the result that the general health of the individual becomes seriously affected and in many cases beyond hope of improvement. Up to a certain point the kidneys can deal with back pressure and even superimposed infection, but beyond this the general effects of renal insufficiency, such as headache, nausea, anorexia, thirst and dry skin, gradually become manifest.

The whole principle of prostatic surgery depends on the renal function, and this must always be assessed before any definite plan can be evolved for dealing with a particular case of obstruction.

Operative interference with the urinary tract, even before any back pressure effects have occurred, throws a strain on the kidneys and, when these are already damaged, may determine a fatal result. Sudden relief of hypertension, as is produced by passing a catheter into and emptying a chronically distended bladder, is extremely badly tolerated, always producing a temporary depression of the renal function, sometimes hæmaturia from rupture of capillary vessels into the renal tubules, and occasionally suppression. This depression of function of kidneys on which excessive demands are already being made may quite easily turn the scale against the recovery of the patient.

Suprapubic cystotomy, with its immediate emptying of the bladder, is a much more serious procedure, as not only does it produce a sudden relief of hypertension, but adds to this the shock of a urological opera-

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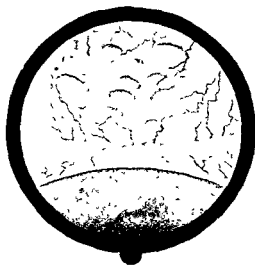


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(6) *Retention of Urine*. Congestion of the prostatic mucosa as a result of instrumentation, even when the utmost gentleness is observed, may be sufficient to determine an attack of acute retention when chronic retention was present before the passage of the catheter or cystoscope.

(7) *Hæmorrhage*. This may occur from congestion of the prostatic mucosa after the passage of a catheter or cystoscope, even in expert hands.

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Suprapubic cystotomy, with its immediate emptying of the bladder, is a much more serious procedure, as not only does it produce a sudden relief of hypertension, but adds to this the shock of a urological operation and the administration of some form of anæsthetic. If to suprapubic cystotomy is also added the removal of the prostate, as in a one-stage prostatectomy, it can be easily understood that this additional strain will more than account for the appalling mortality which is attributed to this operation.

Preliminary investigation and treatment are thus of paramount importance, and together constitute the greatest protection to the patient.

The type of prostatectomy performed, which can be carried out either by the suprapubic, perineal, or perurethral route, varies with the conditions of the prostate as determined by the rectal and cystoscopic examinations, and also, to a large extent, with the preference of the individual surgeon.

In this country suprapubic prostatectomy has the greatest number of followers, and is the method of choice for dealing with the majority of cases of generalised enlargement, and some cases of localised enlargement of the prostate (median lobe) which are giving rise to urinary obstruction.

Perineal prostatectomy, as carried out by Young's or Winsbury-White's technique, however, gives excellent results.

Prostatic fibrosis and some cases of median lobe enlargement, on the other hand, are best dealt with by McCarthy's perurethral resection, a procedure which is increasing in popularity, though considerable instrumental skill is necessary for its efficient performance. Suprapubic resection with the diathermy cutting current, or with Irwin's clamp incisor, is an alternative method to the urethral route, and in some cases will lead to better results.

Suprapubic prostatectomy may be carried out in one stage, with or without preliminary catheter drainage, or be performed in two stages, the prostate being removed after a definite period of suprapubic drainage which itself may be preceded by an indwelling catheter for several days. Chronic retention due to prostatic obstruction is a condition which usually calls for this three-stage method of treatment. A catheter is tied in, the bladder gradually decompressed, and a suprapubic cystotomy performed when the patient's condition is satisfactory. Suprapubic drainage is maintained for a period which may vary from two weeks to several months, and is followed by suprapubic or perineal prostatectomy when the renal function has fully recovered.

Similarly, perurethral resection can be carried out in one stage or be preceded by preliminary catheter drainage, suprapubic cystotomy, or both.

In cases where the patient's general health is good and the obstructing prostate has produced no diminution of renal function (as shown by a normal blood urea, urea concentration, and indigo-carmin tests), suprapubic prostatectomy in one stage is the method of choice. The advantages to the patient, however, of a two-stage operation are so great that they more than outweigh the inconvenience of an additional fortnight in a hospital or nursing home, combined with the risk of a second anæsthetic, even when administered by an expert in gas

and oxygen, and consequently it should always be advised whenever the least doubt arises concerning his general or renal condition.

A common mistake is to suppose that if the urine is free from infection, the danger of a one-stage prostatectomy is small. When the bladder is opened sepsis is invariably introduced, and may cause a greater or lesser degree of urinary infection, occasionally with the production of pyelitis or pyelonephritis, which, in some cases, may persist for ten days or a fortnight before urological resistance to the infection is acquired. The shock of a superadded prostatectomy may determine a fatal issue.

A second-stage prostatectomy is undoubtedly more difficult to perform owing to the shrinkage of the prostate after cystotomy; but this in itself is of some advantage from the point of view of consequent diminution of hæmorrhage, though by the technique of Harris for the reconstruction of the prostatic cavity the risks from both post-operative hæmorrhage and sepsis have been reduced to a minimum. The final decision for a one- or two-stage prostatectomy must depend upon the individual surgeon, who must be guided entirely by his experience, clinical instinct, and by a correct interpretation of all the facts available.

Definite contra-indications. Even two-stage prostatectomy is contra-indicated in the following conditions: Extreme age and increasing feebleness of the patient; failure of preliminary treatment, which may include cystotomy, to improve renal damage; severe sepsis; or severe cardio-vascular, pulmonary, and gastro-intestinal conditions.

As with operations in other parts of the body, certain general principles must be observed. Failure to do this may be directly responsible for complications necessitating prolonged after-treatment, which not only cause the patient additional discomfort, but, what is of greater importance, seriously jeopardise his chances of an uneventful convalescence, and, in some cases, bring about a fatal termination. These principles consist of: (1) General treatment. (2) Adequate drainage. (3) The control of bleeding. (4) The elimination of sepsis.

(1) *General Treatment.* This should always be carried out in conjunction with a physician, who should make careful inquiry into the cardio-vascular, pulmonary, gastro-intestinal and nervous systems, and who should be asked to carry out any treatment which he may consider necessary.

(2) *Drainage.* This may be both pre- and post-operative. Pre-operative drainage, as has been described, may be by catheter, by

suprapubic cystotomy, or by both, the type and duration being determined by the renal function, the amount of residual urine, and the presence of complications.

Post-operative drainage constitutes, perhaps, the most important step in after-treatment, and is effected by a large suprapubic tube for at least five days following suprapubic prostatectomy, or by an indwelling catheter if Harris's operation is performed.

In perineal prostatectomy by Winsbury-White's method a preliminary suprapubic cystotomy is always performed at least fourteen days beforehand, and a self-retaining tube of his pattern inserted. This tube is left undisturbed during and after the perineal prostatectomy, and additional drainage provided by an indwelling catheter and a perineal tube.

In one-stage perurethral resections drainage is maintained by an indwelling catheter which should be as large as possible—i.e. 12–14 English.

(3) *Bleeding.* This is best checked in a one-stage suprapubic operation by Harris's technique, in which the more important vessels are caught by stitches introduced with a boomerang needle. A two-stage operation greatly diminishes the amount of bleeding, and some surgeons make no attempt to control it, a large suprapubic tube providing a free exit for the escape of clots. Others introduce a variety of plugs into the prostatic cavity, such as gauze packing, or rubber bags which are distensible by air or water. The simplest and most efficient of these mechanical means is Andrews' suprapubic tube, to which is attached a flexible india-rubber bag which is placed in the prostatic cavity and temporarily distended with gauze introduced through the tube. If Harris's plastic repair is carried out, these measures are not required.

Winsbury-White's perineal prostatectomy, being a two-stage operation, is not followed by much bleeding, but what there is is most efficiently controlled by suturing the cut urethra and peri-urethral structures to the bladder neck and by the obliteration of the remains of the prostatic cavity by further sutures.

In McCarthy's perurethral resection, and in suprapubic resection, the diathermy cutting loop or knife controls bleeding to a very large extent, and any residual hæmorrhage is arrested at the end of the operation by the coagulating current applied with a button electrode.

(4) *Sepsis.* This is controlled both before and after operation. Pre-operative treatment may be medicinal, hexamine being given

before and an acid mixture after meals for some days before operation. In cases requiring preliminary drainage by catheter, suprapubic cystotomy, or both, intermittent and, in some cases, continuous irrigation of the bladder is carried out and constitutes the most efficient means of diminishing infection.

Post-operative treatment consists of intermittent or continuous bladder wash-outs through the suprapubic tube or indwelling catheter. In one-stage perurethral resection, the latter is the only means of drainage, and irrigation of the bladder is carried out at short intervals for three or four days. After Harris's operation with reconstruction and obliteration of the prostatic cavity, irrigation is unnecessary.

(B) CATHETER DRAINAGE

The regular passage of a catheter may be employed as the sole method of treatment for patients suffering from prostatic obstruction, but this catheter life, although said to be consistent with years of comfort and with normal bodily and mental activity, is a procedure which has little to recommend it. As a rule complications, such as infection, set in which seriously prejudice the patient's condition, and only make subsequent operative procedures more difficult. Catheter drainage is essential as a preliminary to either suprapubic cystotomy or one-stage prostatectomy, in the presence of infection, residual urine over 4 oz. in amount, or if the renal function is below normal. In addition, if chronic retention with overflow is present, the bladder must be gradually decompressed by withdrawing not more than 10 oz. of urine every two hours until it is empty.

The treatment of this condition has been fully described on page 2968.

Technique. The penis with retracted prepuce is well washed and the urethra anaesthetised with cocaine bicarbonate solution. A No. 12 E. gum elastic coude catheter is passed into the bladder and tied in as follows: A piece of adhesive strapping or elastoplast 8 inches long and 1 inch wide is cut, and two tapes $\frac{1}{4}$ inch in width and 10 inches in length folded round the strapping, as shown in figure 1692, the distance between them being equal to half the circumference of the penis. The prepuce is pulled forward and the strapping applied loosely, as consequent swelling of the organ may cause marked oedema of the prepuce and discomfort to the patient. A third piece of tape, about 6 inches long, is tied round the catheter, 1 inch away from the external urinary meatus, and prevented from slipping

by winding a narrow piece of strapping around the knot and adjacent part of the catheter. The ends of the tapes are tied together, as shown in figure 1692, and the catheter so adjusted that lotion injected through a syringe passes freely in and out of the bladder through its lumen. Drainage is effected by means of a glass connecting tube fixed to a length of rubber tubing which dips into a bottle containing antiseptic solution placed at the bedside.

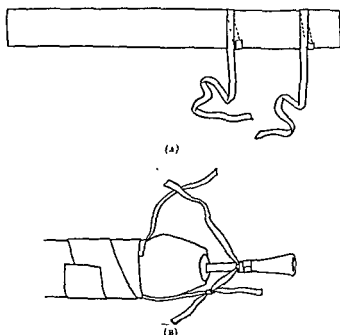


Fig. 1692.—METHOD OF TYING IN A CATHETER.
(A) TAPES ATTACHED TO PIECE OF STRAPPING.
(B) CATHETER IN POSITION, ONE PAIR OF TAPES TIED,
THE OTHER PAIR UNTIED.

The bladder is irrigated with acriflavine 1 in 8000 twice a day or more, according to the severity of the infection, some 4 oz. being left in for half an hour, a spigot being inserted into the catheter after each wash. The catheter is changed every third day, the urethra irrigated with the same solution before insertion, and the glans and prepuce well washed.

After a minimum of ten days, and when the patient's general condition is satisfactory and his renal function tests are good, a one-stage prostatectomy is carried out. In all other cases, suprapubic cystotomy is performed.

(C) SUPRAPUBIC CYSTOTOMY

Indications. (1) For drainage. (2) For removal of stones, foreign bodies and growths unsuitable for perurethral methods. (3) As a

preliminary to operations on the prostate or strictures, or for excision of diverticula. (4) In the presence of bleeding which cannot be controlled by a catheter, or in cases of clot retention in which the clots cannot be removed by suction. (5) As an emergency if a catheter cannot be passed, as in a few cases of acute retention due to stricture.

Preliminary Treatment. It is of the utmost importance to realise that cystotomy may be a severe operation, and should never be carried out as an emergency unless all attempts to pass a catheter have failed, as in some cases of retention due to stricture, or unless it is impossible to empty the bladder through a catheter, as in some cases of clot retention.

Anæsthetic This depends on the condition of the patient. In emergency cystotomies, as in cases of retention due to stricture, *local anæsthesia* is the method of choice. A point is selected midway between the umbilicus and the symphysis pubis, and two separate amounts of 1 cc. each of 1 per cent novocaine are injected with a small needle under the skin one inch on either side of it. After a short interval a long needle is passed through one of these punctures and slowly pushed subcutaneously to a point one inch below the umbilicus, novocaine being introduced continuously with a syringe. The needle is then nearly withdrawn, reversed, and slowly passed to a point one inch above the symphysis, the whole track being again infiltrated. The procedure is repeated on the other side, about 30 to 40 cc. of 1 per cent novocaine being used. The wound area is thus surrounded by a lozenge-shaped subcutaneous infiltration of novocaine, and the incision can be made within five minutes of injection. 10 to 15 cc. are next injected through the anterior rectus sheath into the subjacent muscles in the mid-line, and after a short interval the sheath is opened. Finally, after exposing the bladder wall, 10 or more cc. is injected into its muscular tissue.

In less severe cases of renal damage in which it is thought undesirable to give a general anæsthetic, *intravenous evipan* is the method of choice. Evipan is supplied in solid form in an ampoule of 10 cc. volume. Ampoules containing 10 cc. of triple distilled water are also provided. One of the latter is broken and the water drawn into a 10 cc. sterile syringe and injected into the ampoule of evipan. When this has completely dissolved, the syringe is charged with the solution.

A tourniquet is applied to the patient's upper arm and the median basilic vein rendered prominent by alternately clenching and unclenching the fist.

The skin is painted with spirit and the needle inserted into the vein. The tourniquet is slackened and the injection made slowly, the patient being asked to count. Consciousness is quickly lost, and when the voice is no longer audible it is found that the amount injected usually varies from 3 to 5 cc. A similar amount is then injected slowly, making a total of about 6 to 10 cc.

There should be no delay in commencing the operation, as effective narcosis can only be obtained for about 15 to 20 minutes with the use of evipan.

For routine cases the most efficient and, at the same time, the most pleasant form of anæsthesia is *gas and oxygen*, which should be preceded three-quarters of an hour beforehand by $\frac{1}{16}$ grain of atropine subcutaneously, and intra-rectal avertin, the amount of which depends on the weight of the patient.

Preparation. Two vegetable laxative pills are given 48 hours before operation, a light diet on the day before with plenty of glucose barley sugar to suck, and an enema

early on the morning of the operation. On the preceding night the skin is shaved and painted with 3 per cent picric acid in spirit.

Position. The patient lies flat on his back on an operating table, a tray, which communicates with a bucket underneath the table, being placed between the legs.

Operation. Three per cent picric acid in spirit is applied to the skin of the lower abdomen, external genitals, and the front and inner aspect of the thighs, especial care being directed to the glans penis with retracted prepuce.

A No. 12 English gum elastic coudé or bicoudé catheter is passed into the bladder and any contained urine allowed to flow into the tray. *The viscus is then washed out until the return flow is clear, distended with 10 oz. of boracic lotion, and a spigot inserted.*

Sterile mackintoshes and towels are applied and clipped in position.

In septic cases and as a preliminary to prostatectomy, the vasa deferentia should be ligatured to prevent subsequent *spread of infection to the epididymes*. The vas on each side is isolated from the cord first by the fingers and then by vasotomy forceps, and a small incision made over it. It is grasped with tissue forceps and brought out on to the skin. Kocher's (toothed) forceps are applied on each side and the tissue forceps removed. The vas is cut through and each end ligatured with No. 2 plain catgut; the forceps are then removed and the skin closed with a continuous No. 0 catgut suture and painted with picric acid.

A vertical incision about four inches long is made through the skin and subcutaneous tissues, in the mid-line between the umbilicus and symphysis pubis. The anterior rectus sheath is cut through for the full length of the skin incision, and each half dissected back for about half an inch from the recti muscles in the upper part of the wound and the pyramidales in the lower part. The interval between the two is sought for and the muscles separated with the forefinger of each hand.

The prevesical fold of peritoneum is stripped up by a finger covered with a piece of gauze until the characteristic brownish-red trabeculated musculature of the bladder, with its tortuous veins, comes into view. Care must be exercised not to tear the peritoneum, which at times is adherent to its anterior surface, and at the completion of the stripping process a thorough search should be made for a possible rent, which, if found, must be immediately sutured. (Strangulation of a loop of intestine has been known to occur where this precaution has been neglected.) If the peritoneum is adherent, it is a good plan to begin at the lateral aspect of the bladder where its attachment is rarely firm, leaving the

anterior portion until the last. Stripping is continued until the apex of the bladder, recognisable by the fibrous remains of the urachus, comes into view.

Thomson-Walker's self-retaining retractor with short blades is inserted into the wound and the recti muscles are held widely apart, any bleeding points on the bladder musculature being picked up and ligatured with No. 0 catgut.

Two traction sutures of No. 2 catgut are inserted longitudinally into the bladder on either side of the mid-line, clipped with artery forceps, and the retractor removed.

The spigot is withdrawn from the catheter and all the boracic lotion allowed to run into the tray, being aided by pressure from above on the exposed bladder. The catheter is left in position to drain off any retained fluid.

The traction sutures are held up, the prevesical peritoneal fold retracted, and the bladder incised vertically with pointed scissors as high up as possible between the sutures; the incision is extended as far as the apex (fig. 1693).

The bladder is next explored, the prostate examined from above, and the results of cystoscopy and other examinations confirmed. Should it be necessary, stones are extracted, diverticula are excised, growths removed by fulguration or excision, or a combination of the two, or other procedures carried out, depending on the purpose for which the operation is performed. If the cystotomy is merely part of a one-stage prostatectomy, the subsequent procedures will be found described on page 2986. In other cases the wound is closed with drainage.

Closure of the Bladder with Drainage. The ultimate object of this procedure is to obtain quick and firm healing of the cystotomy wound, and two important causes of delay or non-healing must constantly be borne in mind and guarded against. These are: Firstly, too close an approximation of the bladder wall and skin, with the result that in many cases there is some degree of prolapse of bladder mucous membrane through the wound. Secondly, adhesions between the anterior surface of the bladder and the symphysis pubis, which result from inadequate drainage of the prevesical space of Retzius.

Thomson-Walker's retractor with short blades is inserted into the wound and the recti muscles held widely apart. The lower end of the bladder wound is sewn together with interrupted sutures of No. 0 catgut, and a No. 40 Charrière Winsbury-White suprapubic tube inserted into the uppermost extremity of the bladder incision.

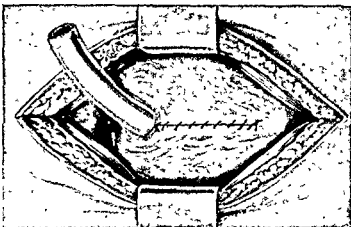


Fig. 1695.—BLADDER INCISION COMPLETELY SUTURED.

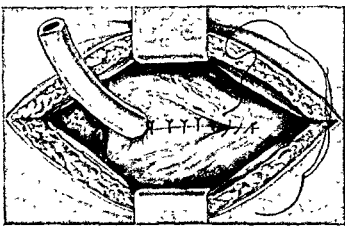


Fig. 1694.—SUPRAPUBIC CYSTOSTOMY: WISS-BURY-WHITE TUBE IN POSITION; INTERRUPTED SUTURES TIED AND CONTINUOUS SUTURE PARTIALLY INSERTED.

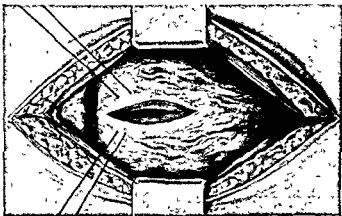


Fig. 1693.—SUPRAPUBIC CYSTOSTOMY: INCISION OF BLADDER BETWEEN TRACTION SUTURES.

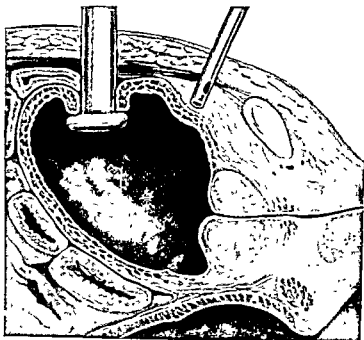


Fig. 1693.—SUPRAPUBIC CYSTOTOMY, OPERATION COMPLETED.

Additional sutures are inserted into the bladder wound until the tube is firmly gripped, but none is passed through it.

The sutures are next oversewn by a continuous stitch of No. 0 catgut, care being taken to invert all parts of mucous membrane which may still be visible (figs. 1694 and 1695). In this way the margins of the bladder wound around the tube are inverted in much the same manner as in the performance of a gastrotomy, leakage into the prevesical space being thus reduced to a minimum.

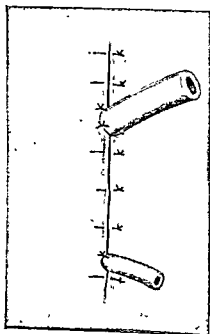


Fig. 1697.—SUPRAPUBIC CYSTOTOMY; OPERATION COMPLETED.

By pushing the tube inwards the whole bladder is forced into the pelvis, thus ensuring that the distance between it and the skin shall be as great as possible, and thereby guarding against one of the causes of delay in healing.

The Thomson-Walker retractor is removed and a rubber tube,

$\frac{1}{4}$ inch in diameter, with a lateral opening is passed into the prevesical space. This constitutes an efficient drain and still further pushes the anterior wall down into the pelvis, thereby to a great extent preventing the formation of adhesions to the symphysis pubis—another cause of delayed healing (fig. 1696).

The rectus sheath is picked up and sewn together with interrupted stitches of No. 2 catgut, the prevesical drain being brought out at the lower extremity of the wound, and the suprapubic tube as near the upper extremity as can be conveniently reached. This is of great importance when cystotomy is a preliminary to prostatectomy, as it provides adequate room for subsequent removal of the prostate without the necessity of opening up that part of the wound above the bladder tube which overlies the peritoneal reflection; in this way it is possible to avoid all risk of opening the peritoneal cavity.

If permanent suprapubic drainage is desired, the maximum length of track is secured, thus preventing leakage past the catheter. The skin is closed with interrupted sutures of fishing-gut, using the eversion stitch. Finally, both tubes are pushed into the wound as far as possible and stitched securely in position. It is well to pass two stitches through the bladder tube as an additional precaution against the bladder rising to the surface (fig. 1697).

The catheter is removed from the urethra, picric acid painted on the wound, and dry dressings applied.

After-Treatment. The suprapubic tube is attached by means of a glass connection to a long tube communicating with a large narrow-necked bottle containing lysol. Heroin $\frac{1}{8}$ gr. or morphia $\frac{1}{4}$ gr. are given if necessary, when the patient has come round from the anæsthetic. An enema is administered two days after the operation, and repeated twelve-hourly until an action of the bowels is obtained, when a suitable aperient, such as two vegetable laxative pills or two drachms of cascara evacuant, is given.

Alkalis and fluids, such as water, Contrexéville, Vittel, and barley-water are encouraged and the bladder washed out twice daily through the suprapubic tube.

The prevesical tube is removed on the fourth to sixth day and the stitches on the ninth day.

After the bowels have been opened food is allowed, and this should be nutritious, its nitrogen content varying inversely with the amount of renal damage, as previously determined.

If a second-stage prostatectomy is contemplated, the renal function is estimated on the twelfth day by the blood urea and urea concentration tests. The blood urea should not exceed 50 mgms. per cent, and the urea concentration should be 2 per cent or over during the second and third hour.

Should both clinical and laboratory findings show that the patient is ready for prostatectomy, this should be performed on the fourteenth day after the cystotomy, either by the suprapubic or the perineal route.

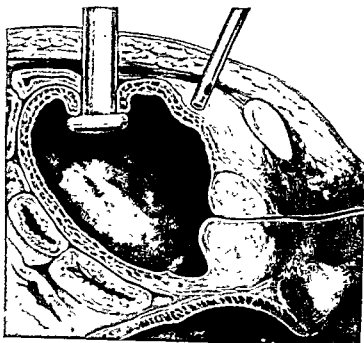


Fig. 1695.—SCRAPUBIC CYSTOTOMY; OPERATION COMPLETED.

Additional sutures are inserted into the bladder wound until the tube is firmly gripped, but none is passed through it.

The sutures are next oversewn by a continuous stitch of No. 0 catgut, care being taken to invert all parts of mucous membrane which may still be visible (figs. 1694 and 1695). In this way the margins of the bladder wound around the tube are inverted in much the same manner as in the performance of a gastrostomy, leakage into the prevesical space being thus reduced to a minimum.

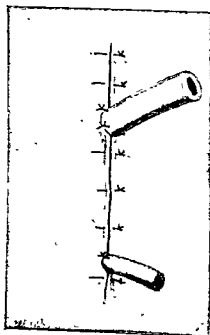


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The catheter is removed from the urethra, picric acid painted on the wound, and dry dressings applied.

After-Treatment. The suprapubic tube is attached by means of a glass connection to a long tube communicating with a large narrow-necked bottle containing lysol. Heroin $\frac{1}{4}$ gr. or morphia $\frac{1}{4}$ gr. are given if necessary, when the patient has come round from the anæsthetic. An enema is administered two days after the operation, and repeated twelve-hourly until an action of the bowels is obtained, when a suitable aperient, such as two vegetable laxative pills or two drachms of cascara evacuant, is given.

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After the bowels have been opened, food is allowed, and this should be nutritious, its nitrogen content varying inversely with the amount of renal damage, as previously determined.

If a second-stage prostatectomy is contemplated, the renal function is estimated on the twelfth day by the blood urea and urea concentration tests. The blood urea should not exceed 50 mgms. per cent, and the urea concentration should be 2 per cent or over during the second and third hour.

Should both clinical and laboratory findings show that the patient is ready for prostatectomy, this should be performed on the fourteenth day after the cystotomy, either by the suprapubic or the perineal route.

In some cases a fortnight is not long enough for these findings to prove satisfactory, and the investigations should then be repeated at weekly intervals. In others, prolonged suprapubic drainage, even for periods up to six months, may be necessary. In these cases the wound is allowed to heal down to a small-sized de Pezzer catheter which is changed at regular intervals. The patient is fitted with a belt to which is slung a rubber urinal connecting with the catheter, and he is allowed to get up, go home, and lead his normal life as far as possible.

The renal function tests are repeated at monthly intervals, and prostatectomy advised when they become normal.

In a small percentage of cases, in which little or no improvement is shown, perurethral prostatectomy may be considered as an alternative to permanent cystotomy.

(D) SECOND-STAGE PROSTATECTOMY

Preparation. An enema is given and the bladder washed out through the suprapubic tube on the morning of the operation.

Anæsthetic. (As for Suprapubic Cystotomy.)

Position. (As for Suprapubic Cystotomy.)

Operation. The patient is rolled for a moment on to his side and an injection of 20 cc. of coagulen-ciba is given into one buttock. The suprapubic tube is removed by a sharp tug, and any blood or urine which has emerged from the wound is carefully removed with sterile swabs. The abdomen is painted with 3 per cent picric acid in spirit and mackintoshes and towels are arranged and clipped into position.

Long narrow gauze swabs are inserted into the bladder through the suprapubic track and its cavity gently mopped dry. Two incisions are made, each beginning about 1 inch above the suprapubic opening, passing down to the outer side of the cystotomy wound, converging below this to within $\frac{1}{4}$ inch of each other, and running vertically downwards on either side of the partially healed suprapubic scar and meeting at its lower extremity. The scar and as much of the suprapubic track as possible are excised and the skin edges undercut for about 1 inch on either side.

An incision is next made which begins at the lower margin of the cystotomy opening and runs vertically downwards to the lower end of the skin wound. The knife divides accurately in the mid-line all the tissues, which consist mainly of granulation tissue uniting the anterior rectus sheath, the two recti muscles and the anterior bladder wall. Any bleeding points are picked up and ligatured and the bladder again mopped dry with gauze swabs. The towels covering the patient's left leg are turned back and the latter is raised by a nurse. The first or

second finger of the surgeon's left hand, previously lubricated with vaseline, is inserted into the rectum and the prostate pushed up into the bladder as far as possible.

The internal meatus is sought for, the right forefinger inserted into it, and the mucous membrane at the antero-inferior margin of one or other lateral lobe broken through, just external to the verumontanum. The inferior and superior borders of the lateral lobes are followed round to the mid-line, first on one side and then on the other, the finger slipping into the line of cleavage between the adenomatous portion and the false capsule of the prostate, the latter consisting of the flattened out remains of normal prostatic tissue which has come to line the fibrous or true capsule. By this method the prostate is quickly removed with great gentleness and ease, and with the minimum of bruising and disturbance of the surrounding tissues.



Fig. 1699.—ANDREWS' SUPRAPUBIC TUBE.

Prostatectomy consists, therefore, of the enucleation of the pathological from the normal prostate, and not of a total removal of the gland. It is for this reason that prostatic hypertrophy may recur after operation, however skilfully performed.

All parts of the prostatic capsule are palpated bimanually and any small adenomata or tags removed.

Unless Harris's technique is employed, the next step in the operation, and one which is of the utmost importance in preventing subsequent contraction of the communication between the bladder and prostatic cavity, consists in splitting the posterior commissure in the middle line until the finger can be passed from one cavity to the other without any intervening elevation. As a rule the greater the intravesical projection of the prostate, the larger is this vesico-prostatic opening and the less is the risk of subsequent stenosis.

The flexible rubber bag of a No. 26 E. Andrews' suprapubic tube (fig. 1698) is partially filled with ribbon gauze, by means of an introducer, and inserted into the bladder. The bag is pushed into the prostatic cavity where it can easily be felt by the left forefinger which still remains in the rectum. The bag is further distended with ribbon

gauze, introduced by the assistant, until the prostatic cavity is completely but not too tightly filled, at which point the left finger is withdrawn from the rectum. The glove is stripped off by a nurse and the left hand examined for blood, indicating perforation, which calls for careful washing in disinfectant lotion. A fresh glove is put on before continuing the operation.

The anterior bladder wall and anterior rectus sheath which, as a rule, cannot be differentiated, are united with a few interrupted sutures of No. 2 chromicized catgut and the skin approximated with fishing-gut eversion sutures. Two stitches are inserted through the skin on either side of the Andrews' tube, which is picked up by them at its upper and lower margins.

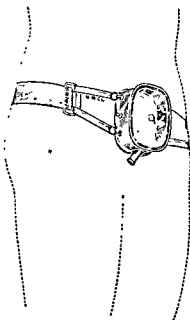


Fig. 1699.—AUTHOR'S SUPRAFURIC BOX.

The wound and surrounding skin are carefully cleansed, a mixture of equal parts of zinc oxide and castor oil applied, and one of the various types of suprapubic boxes fitted over the incision and retained in place by an elastic band encircling the waist. A convenient pattern made of celluloid has been made to my design by the Genito-Urinary Mfg. Co. (fig. 1699). A sterile towel is placed over the abdomen and the patient returned to bed, when the single opening of the box is connected

by means of a long rubber tube with a narrow-necked bottle on the floor filled with disinfectant.

After-Treatment. Heroin $\frac{1}{8}$ gr. or morphia $\frac{1}{4}$ gr. is given when the patient has recovered from the anæsthetic, and smaller doses are repeated six-hourly if necessary. The bladder is washed out twice daily through the Andrews' tube by inserting a small rubber catheter down it and using a 6-oz. rubber bladder syringe. Half the ribbon gauze is withdrawn in 24 hours and the remainder in 48, causing no discomfort to the patient as it is not in direct contact with the raw prostatic cavity. As a rule bleeding has ceased by the 5th day, when Andrews' tube is removed, after cutting the two anchoring sutures, and a small rubber tube of $\frac{1}{2}$ -inch diameter is inserted for two days. Irrigations are continued with a small rubber catheter intro-

duced through the wound until the latter becomes too small, which usually occurs about the 12th to 14th day. The urethra is then anæsthetised with cocaine bicarbonate solution and a No. 14 English bicoudé gum elastic catheter passed to ensure the patency of the new vesical outlet. A little bleeding commonly follows, and there may be some rise of temperature due to the passage of infected urine over the raw area. Micturition is established about the 14th to 18th day and the wound is dry a few days later, when dressings are substituted for the suprapubic box and the patient is gradually allowed up. If delay in healing occurs, a catheter should be tied in for a few days and the wound edges drawn together with adhesive strapping. The wound should be firmly healed in from three to four weeks after prostatectomy. The bowels and diet are regulated in the same way as after cystotomy. Fluids and alkalis are given for about a week, after which hexamine 10 grs. before and an acid mixture after meals are given to diminish infection and prevent the formation of phosphatic stones.

Complications of Suprapubic Prostatectomy. (One-or two-stage.)

(b) *Reactionary.*

(1) *Hæmorrhage.* (a) *Primary*: at time of operation.

This is reduced by an injection of coagulen-ciba, and is easily controlled by an Andrews' suprapubic tube. If Harris's plastic repair is carried out at all, bleeding is arrested by sutures.

(c) *Secondary.*

This is uncommon if Harris's technique is employed. Coagulen-ciba, heroin, morphia, or hot bladder wash-outs with weak silver nitrate solution 1 in 8000 are usually sufficient to control it, though blood-transfusion may be necessary at times and should not be delayed if simple measures fail.

(2) *Pain.* *This used to be a common feature when the prostatic cavity was packed with gauze, or when a bag such as Pilcher's was inserted into it. By the use of Andrews' suprapubic tube the severity of the pain is much reduced and can be further diminished by withdrawing some of the gauze plugging from its interior and by irrigating the bladder through the tube.*

(3) *Shock.* *This results from hæmorrhage, prolonged operation, or rough manipulation, usually in a patient whose renal function is impaired.*

In a two-stage operation the prostate is always more difficult to enucleate due to marked shrinking of the gland, and consequently there is some increased shock.

By Harris's method the plastic repair is quickly performed and prevents the shock which is due to hæmorrhage.

Fibrous prostates should always be dealt with by perurethral resection.

(4) *Renal Failure.* *This can be prevented in great measure by pre-operative treatment, the most important part being drainage by catheter and cystotomy. Adequate time must be allowed for the kidneys to recover, and the second stage not*

performed until the general condition and renal function tests are good. Post-operative renal failure must be treated by fluids, diuretics, intravenous salines, and radiant heat to the renal areas.

(5) *Infection.* Some degree of cystitis is always present. This may be pre-operative and, if mild, is usually an advantage. If severe it always improves after adequate bladder drainage. It may, however, be post-operative due to introduction of organisms through the cystotomy wound—usually a mixture of the *B. coli* group, staphylococci, streptococci and *B. proteus*. Plastic repair of the prostatic cavity whereby little raw surface is left behind is of paramount importance in minimising its spread, while the routine bladder wash-outs, fluids, and alkalis which are given after operation are usually enough to diminish its intensity. Rarely, however, it may spread to the kidneys and pyelonephritis cause much anxiety.

Some rise of temperature after operation is the rule but if persistent is usually due to extravescical cellulitis from inadequate drainage.

Epididymitis is prevented by vaso-ligature, but occasionally an abscess may form at the cut end of the proximal part of one vas which will require fomentations and sometimes incision.

Gross factors of persistent infection, such as a diverticulum, should be seen during the preliminary cystoscopy, and should have been dealt with at the time of the cystotomy.

(6) *Post-operative Obstruction.* This used to occur in a definite number of cases, especially when the gland was of the fibrous type. By plastic repair of the prostatic cavity and perurethral resection of fibrous prostates this complication should not occur, but, as other methods are frequently employed, a number of late cases are seen in which conditions are often much worse than before operation. The suprapubic wound has often re-opened, cystitis is present, stones have formed in the bladder, and the patient is in serious doubt as to whether his operation has been successful, a satisfactory explanation being impossible in most cases.

Early obstructions often give rise to some degree of incontinence, but usually respond to intermittent dilatation under local anaesthesia with bougies and Kollmann's dilator. Late obstructions may require continuous treatment with indwelling catheters followed by perurethral resection of the bladder neck.

(7) *Stone Formation.* The formation of phosphatic stones is a common complication, unless the urine is kept acid by an acid mixture, and constitutes one cause of the non-healing of the suprapubic wound. If this complication has occurred, no time should be lost in enlarging the suprapubic track and extracting the calculi by means of Young's cystoscopic rongeur.

(E) ONE-STAGE SUPRAPUBIC PROSTATECTOMY WITH CLOSURE (HARRIS'S OPERATION)

The operation to be described has been evolved by Harris after several years of experiment and, in its present form, has been practised by him for over six years. It is characterised by an easy convalescence, and patients submitted to it require, on the average, far less individual,

albeit skilled, attention after operation than those submitted to the two-stage operation which has just been described. In the following description, extracts have been made from Harris's own writings.¹

The particular features of the operation are briefly :

(1) The complete and immediate control of hæmorrhage by suture.

(2) The covering of all raw surfaces in such a way that the greater part of the prostatic urethra is re-formed and the prostatic cavity obliterated, with the result that healing generally takes place by first intention and without urinary leakage. Septic complications are very rare, fistula formation does not occur, and post-operative recurrence of obstruction is completely obviated.



Fig. 1700.—BOOMERANG NEEDLE HOLDER.

Two factors are of paramount importance, and inattention to either is likely to entail failure of the plastic portion of the operation, however carefully this may have been carried out. These are :

(1) The employment of surgical asepsis and antisepsis in the management of the catheter in both pre- and post-operative periods.

(2) The employment of an intra-urethral method of digital enucleation of the prostate, whereby the verumontanum is preserved, the anterior commissure is not disturbed, and the mucosal covering of the greater part of the prostatic urethra is left intact.

Surgeons who have had no experience of Harris's operation are advised to complete the operation with drainage until they have acquired some experience of the method, and can be certain of ensuring complete hæmostasis; and, in addition, to make a longer vertical or transverse abdominal incision rather than the shorter one about to be described.

Harris himself as a routine terminates the operation with complete closure, although he particularly insists that it should be practised only when the local conditions warrant it. It



Fig. 1701.—HARRIS'S LARGE-SIZE BOOMERANG NEEDLE. THERE IS NO CUTTING EDGE. THE POINT ALONE IS SHARP. ($\times \frac{1}{2}$.)

(British Journal of Surgery.)

¹ S. Harry Harris, "Prostatectomy with Closure." *British Journal of Surgery*, and *Australian and N.Z. Journal of Surgery*.

should be regarded as the fulfilment of a successful operation in a field rendered favourable for its accomplishment. He is very definite also that when a wide incision of the bladder and abdominal parietes is practised, drainage of the pievesical space at least must be provided.

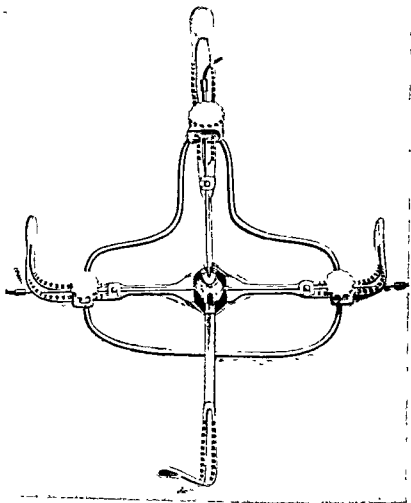


Fig. 1702.—HARRIS'S ELECTRICALLY LIGHTED BLADDER RETRACTORS AND SELF RETAINING FRAME. THE ANTERIOR RETRACTOR IS NOT ELECTRICALLY LIGHTED AND DOES NOT CONNECT WITH THE FRAME.

(*British Journal of Surgery*)

Four special instruments are required :

(1) The boomerang needle holder (fig. 1700). Two sizes of needle are employed, the larger is indispensable for the placing of the trigonal and the anterior oblitative sutures (fig. 1701). A smaller needle is used for the lateral hæmostatic sutures. To avoid hæmorrhage from the needle puncture, it is important that it should not have a sharp terminal cutting edge. The needle should be sharpened only at its actual point.

(2) A curved ligature carrier for the boomerang needle holder.

(3) Harris's illuminated bladder retractors and self-retaining frame (fig. 1702).

(4) Anterior retractor with extensible blade (fig. 1703), which permits of ready adjustment to the varying depths at which the prostatic cavity is found in different subjects.

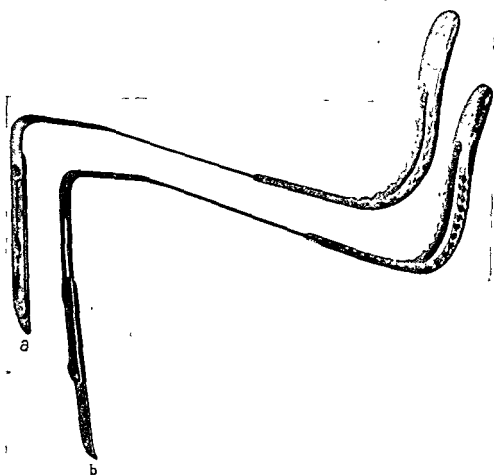


Fig. 1703.—HARRIS'S ANTERIOR RETRACTOR. (a) CLOSED. (b) EXTENDED.

(*Australian and New Zealand Journal of Surgery.*)

For a successful result it is of the utmost importance that all who intend to perform this operation should follow the technique in its entirety. It is proposed, therefore, to describe Harris's technique in detail, including pre-operative preparation and post-operative care of the patient.

Preparatory Treatment. The patient must be made to drink as much fluid as is reasonably possible throughout both the pre-operative and post-operative periods. Neither subcutaneous nor intravenous salines are given.

Preliminary catheter drainage is employed for at least ten days, or preliminary

cystotomy for at least one month if catheterisation is unsuccessful (10 per cent of cases), if the urine is dirty, if the residual urine exceeds 4 oz., or if the renal function is below par. Patients whose general condition is unsatisfactory, and who for that reason require pre-operative preparation, often improve to an extraordinary extent with a retained catheter, and even when no residual urine is present and there is a normal renal function. The improved rest at night thus rendered possible is doubtless a potent factor.

Vaso-ligature for the prevention of epididymitis is practised as a routine and is carried out with silkworm-gut subcutaneous transfixion sutures which are inserted preferably at the time of the first catheterisation and are removed after seven days. They are tied sufficiently tightly to occlude the lymphatics surrounding the vas, without obstructing its lumen. The following routine is rigidly insisted upon when a retained catheter is employed. : The bladder is washed out once, or in cases where the urine is foul, twice, or even thrice daily with potassium permanganate 1 in 8000, then with plain sterile water, after which it is completely emptied. 4 oz. of 1 in 4000 silver nitrate solution are then run into the bladder and the catheter is clamped for half an hour. When the bladder contents are foul, the strength of silver nitrate is increased to the limit of tolerance, sometimes even up to 1 in 2000, but in no circumstances should the solution be strong enough to cause pain. The catheter is drained by a glass connecting tube and a length of rubber tubing into a bottle at the bedside containing antiseptic solution, into which the tubing dips. No method of antiseptics will clean up a dirty bladder or prevent infection of a clean one when the end of the catheter is placed, as is often seen, in a urinal between the patient's thighs. The catheter is changed every third day and, if well enough, the patient is given a hot bath between changes. Before re-insertion of the catheter the glans penis is swabbed with methylated spirit and the urethra irrigated with a 1 in 5000 solution of oxycyanide of mercury.

Hexamine 10 grs. before meals and ammonium benzoate 15 to 20 grs. are given by mouth three times a day. When ammonium benzoate disagrees with the patient, acid ammonium phosphate is substituted in the same dosage.

When conscientiously carried out there will be few, even badly infected bladders which cannot be cleansed, thus rendering the prostatic bed safe for plastic surgery. Confinement to bed is usually only necessary for the first two or three days of catheter treatment. A comfortable chair and sunlight are great assets.

After a minimum of ten days of catheter drainage, and when the patient's general condition is considered favourable, an intravenous injection of 10 cc. of 0.1 per cent solution of indigo-carmin is given. In no circumstances is prostatectomy undertaken, whatever the other tests of renal function may indicate, unless a good blue coloration appears in the urine within ten minutes of injection.

The preparation of the patient, the anæsthetic, and the position are the same as for cystotomy.

OPERATIVE TECHNIQUE

The steps of the operation are summarised as follows :

- (1) Irrigation of the urethra and washing out and complete emptying of the bladder immediately before the patient is brought to the theatre.

(2) Draping of the towels on the patient in such a way that separate and individual access may be had to the rectum, penis, and abdominal incision. The first towel is placed across and depressed between the patient's thighs, the upper edge lying well below the external genitals and anus. A second smaller towel is placed over the external genitals and the penis drawn through a small hole near its upper margin. A third towel is placed over the first two, its upper margin just reaching the symphysis pubis. The remaining towels are draped in the usual way.

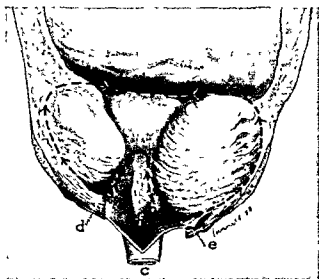


Fig. 1704.—DRAWING OF POST MORTEM SPECIMEN OF BLADDER AND PROSTATIC URETHRA, OPENED FROM THE FRONT TO ILLUSTRATE THE INTRA URETHRAL METHOD OF ENUCLEATION OF THE PROSTATE. THE BROKEN BLACK LINE AND THE ARROWS THEREON INDICATE THE COURSE FOLLOWED BY THE FINGER DURING THE ENUCLEATION.

a and b = Beginning of enucleation.

d and e = Cut edges of muscle of anterior commissure.

f = Prostatic urethra.

c = Membranous urethra.

(*British Journal of Surgery.*)

(3) Transverse abdominal incision through the skin and fat, $2\frac{1}{2}$ to 3 inches in length and 1 inch above the level of the symphysis pubis for a one-stage, or 2 inches above for a two-stage operation.

(4) Incision of the bladder at the highest point after pushing back the peritoneal reflection. All bleeding points on the cut edge of the bladder are carefully tied to ensure that there will be no post-operation bleeding from this source.

(5) Enucleation of the prostate: A bimanual method of intra-urethral enucleation of the prostate is employed. The forefinger of the right hand is passed into the prostatic urethra and breaks its way

through the mucous membrane at the antero-inferior aspect of one or other lateral lobes immediately lateral to the verumontanum. The meso-inferior aspect of each lateral lobe in turn is followed backwards to the mid-line (fig. 1704). Then and only then is the enucleating finger swept round the outer aspect of each lateral lobe from before backwards to the mid-line. The verumontanum is preserved, the anterior commissure is rarely disturbed and much of the prostatic urethra

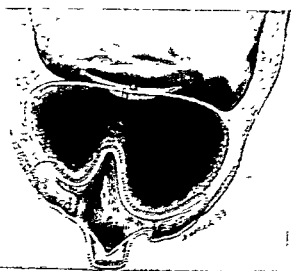


Fig. 1704.—SAME SPECIMEN AS FIG. 1704 AFTER ENUCLEATION OF THE PROSTATE. THE HEAVY WHITE LINE OUTLINES THE RESULTING CAVITY. IT WILL BE NOTED THAT THE PROSTATIC URETHRA AROUND AND DISTAL TO IT HAS BEEN LEFT INTACT. THE ANTERIOR COMMISSURE HAS BEEN DIVIDED IN THIS SPECIMEN TO SHOW THE INTERIOR OF THE PROSTATIC URETHRA; DURING AN ACTUAL OPERATION IT IS LEFT INTACT.

a = Inter-urethral sac.

b = Ischioanal muscle.

c = Membranous urethra.

d and e = Cut edges of the muscle of the anterior commissure.

f = Verumontanum.

(*British Journal of Surgery*.)

remains intact (fig. 1705). By this method the prostate can be cleanly and speedily removed with the greatest gentleness and facility, and with the minimum of bruising and disturbance of the surrounding tissues.

(6) Placing in position of the bladder retractors.

(7) Swabbing out of the bladder and prostatic cavity with small gauze swabs held by 8-inch alligator forceps, and visualisation of the prostatic cavity and removal of any adenomatous remnants or tags.

(8) Insertion of the individual hæmostatic sutures in the postero-lateral segment of the prostatic rim to control the prostatic hæmorrhage.

(9) Retrigonisation, or reconstruction of the floor of the prostatic urethra, by suturing the trigone of the bladder into the prostatic cavity (fig. 1706).

(10) Obliteration of the prostatic cavity and reformation, at least in part, of the side walls of the new prostatic urethra by means of two deep inverting anterior transverse sutures of No. 3 plain catgut. This step also finally controls the venous oozing that always takes place from the prostatic cavity after prostatectomy. Very rarely a third suture may be required when an extra large cavity is present. All bleeding should be controlled before the passage of the urethral catheter which plays no part in the control of hæmorrhage, ample room always being left to allow of drainage upwards into the bladder from the remnant of the prostatic cavity.

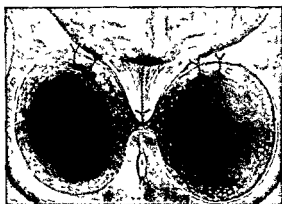


Fig. 1706.—SAME SPECIMEN AS FIGS. 1704 AND 1705.
THE TRIGONE IS SHOWN SUTURED IN POSITION.
(*British Journal of Surgery.*)

(11) Insertion through the urethra into the bladder of a rubber catheter size 22 degrees Charrière, and 12 degrees internal calibre; preparation of its vesical end and transfixion by a needle threaded with silkworm-gut.

(12) Valvular closure of the bladder, obliteration of the space of Retzius and closure of the lower angle of the incision in the aponeurosis by one single three-looped suture of No. 3 plain catgut (see fig. 1712).

(13) Complete closure of the abdominal wall. Harris emphasises most strongly, however, that in no circumstances whatever should the complete closure be carried out where hæmorrhage has not been adequately controlled by suture, or where the pre-operative cleansing of the bladder has not been efficiently carried out. Where a long incision has been made in the bladder or abdominal parietes, drainage of the prevesical space is always provided.

(14) Suspension of the vesical end of the catheter by tying a silk-worm-gut transfixion suture round a glass rod lying on the abdominal wall (see fig. 1712). The catheter is removed on the tenth day and at no time thereafter is the passage of a urethral sound necessary.

THE POSTERO-LATERAL HÆMOSTATIC SUTURES

From two to four sutures of No. 2 plain catgut are placed deeply on either side of the mid-line in the posterior third of the rim of the prostatic cavity (see figs. 1706 and 1707), the smaller of Harris's boomerang needles being used. From this situation alone, in a properly con-

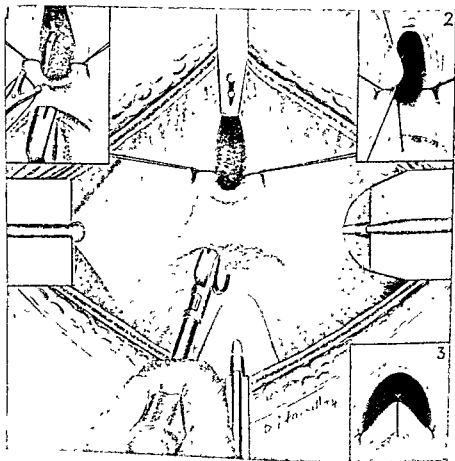


Fig 1707.—ILLUSTRATING THE RETRIGONISATION OF THE PROSTATIC URETHRA. THE MAIN FIGURE SHOWS THE POINT OF ENTRY OF THE NEEDLE IN THE BLADDER BASE WELL DOWN BEHIND THE INTER-URETERIC BAR. INSET 1 SHOWS THE POINT OF EMERGENCE OF THE NEEDLE WELL FORWARD IN THE PROSTATIC CAVITY AND THE SUTURE CARRIER APPROACHING THE NEEDLE. INSET 2 SHOWS THE LOOP WELL DOWN INTO THE PROSTATIC CAVITY, WITH THE FOREFINGER OF THE LEFT HAND PRESSING THE TIED, SEWING THE TRIGONE WELL DOWN INTO THE PROSTATIC CAVITY, BOTH OBLITERATING THE LEDGE IN THIS SITUATION AND RE-FORMING, AT LEAST IN PART, THE NEW PROSTATIC URETHRA. FOR THE SAKE OF SIMPLICITY, ONLY TWO HÆMOSTATIC SUTURES ARE ILLUSTRATED IN ALL FIGURES.

(Australian and New Zealand Journal of Surgery.)

ducted enucleation, is gross hæmorrhage to be anticipated. Should bleeding persist, further sutures should be placed as required. If the bleeding comes from in between two sutures, the loose ends of these sutures may be tied together. In no circumstances, however, is a hæmostatic suture of one side tied across the mid-line to a hæmostatic suture on the other side, as this would prevent satisfactory retrigonisation and thus deliberately encourage ledge formation.

After bleeding has been controlled in the region served by these postero-lateral sutures, careful inspection will occasionally reveal gross bleeding from a large artery or vein lying deeply on the more anterior portion of the prostatic rim. When this occurs, an individual suture should be placed around the bleeding point, since the anterior oblitative sutures, when they are tied, may not afford sufficient compression. It is a *sine qua non* that all bleeding from the prostatic rim must be definitely checked before proceeding further.

When the bleeding is arterial, the sutures should be placed in the prostatic rim in front of the bleeding point; when venous, behind.

THE POSTERIOR OR RETRIGONISATION SUTURE

When the posterior or retrigonisation suture is tied, the torn apex of the trigone is carried down into the prostatic cavity; retrigonisation is brought about and the floor of the prostatic urethra is reconstructed.

Owing to a technical improvement in the placing of this suture, the difficulties of this stage of the operation have disappeared. The point of entry of the needle is now well down behind the inter-ureteric bar or base of the trigone, generally at the deepest part of the bas fond (figs. 1707 and 1708). It is, of course, necessary to visualise the ureteric orifices before inserting the needle; no fear need then be entertained of their compression when the suture is tied. The point of emergence of the needle is deep down in the floor of the prostatic cavity (see fig. 1708). A much wider and deeper extent of tissue is, with ease and certainty, included in the bite of the needle than was previously possible when the point of entry was at the base of the trigone. The special capsule forceps, hitherto employed at this stage of the operation, are now rarely, if ever, necessary.

The deeper the apex of the trigone is carried into the prostatic cavity, *ceteris paribus*, the better, though it is only necessary that it be at least deep enough to ensure that the horizontal muscular ledge which appears in this position after removal of the prostate is converted into a smooth vertical gutter. No attempt is made, nor is it

deemed desirable, to unite the torn apex of the trigone to the verumontanum or to the torn edges of the prostatic urethra. The lowering of the bladder outlet will be even further accentuated when the anterior transverse oblitative and inversion sutures are tied (see fig. 1711), and the trigone becomes firmly bedded in position.

While the retrigonisation suture is being tied, the tip of the operator's left forefinger, if he is standing on the patient's left side, should push the knot as far down as possible into the prostatic cavity (fig. 1709), which ensures that the trigone is carried down to the lowest part of

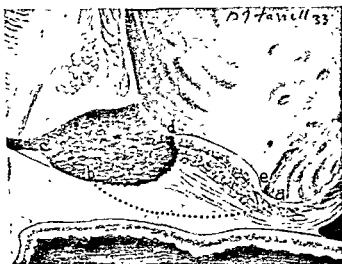


Fig 1708.—ILLUSTRATING THE NEEDLE TRACKS (a-b) FOR THE RETRIGONISATION SUTURE. A SECTIONAL VIEW OF THE ENVIRONS AFTER PROSTATECTOMY.

- a=Point of entry of the needle.
- b=Point of exit.
- c=Verumontanum.
- d=Torn apex of trigone.
- e=Base of trigone.

(*Australian and New Zealand Journal of Surgery.*)

the loop when it is tied. If the right forefinger is used for this purpose, it will be found very difficult to pass it deeply enough into the prostatic cavity, and the tendency will be to draw the trigone upwards away from the prostatic cavity when tying the knot.

THE ANTERIOR TRANSVERSE OBLITERATIVE AND INVERSION SUTURES

A higher degree of efficiency has been attained for the anterior transverse oblitative sutures by considerably increasing the width of their embrace. There results from this not only more nearly complete

obliteration of the prostatic cavity and better hæmostasis of the prostatic bed, but also a wide inversion of the rim and adjoining portion of the bladder base, the side walls of the new prostatic urethra being thus largely re-formed. During the process of tying these sutures the trigone and bladder outlet sink progressively to a lower plane, until finally the trigone disappears almost entirely from view. At the termination of this portion of the operation there should be no visible raw surface and no bleeding.

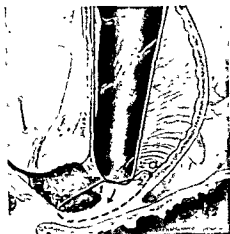


Fig. 1709.—SECTIONAL VIEW SHOWING THE METHOD OF TYING THE TRIGONAL SUTURE, THE LEFT FOREFINGER PUSHING WELL DOWN INTO THE PROSTATIC CAVITY.

ab. Tracks of needle.

1. Torn apex of trigone.

2. Inter ureteric bar.

(*British Journal of Surgery.*)



Fig. 1710.—NEEDLE IN POSITION FOR THE FIRST ANTERIOR TRANSVERSE OBLITERATIVE SUTURE. NOTE THE WIDTH OF THE BITE OF THE NEEDLE. TRIGONAL TONGUE IN POSITION—TWO HÆMOSTATIC SUTURES ONLY ARE ILLUSTRATED FOR THE SAKE OF SIMPLICITY.

(*British Journal of Surgery.*)

In the great majority of cases two anterior transverse oblitative sutures are employed, though one may suffice for a very small cavity; a particularly large cavity may very occasionally demand the use of three. One suture is tied before the next is placed.

The first or most anterior suture passes transversely at a tangent to the anterior segment of the prostatic rim (fig. 1710). The second is parallel to the first and bisects what remains of the prostatic cavity. These sutures traverse the prostatic cavity deeply from side to side, just missing its floor in the depths. They will lie above and in front of the catheter when it is passed. Modifications of this simple and straightforward technique have been suggested from time to time, due mainly to lack of familiarity with the boomerang needle holder. Almost without exception these fundamentally alter the character of the operation, and fail to accomplish the broad, smooth, deep inversion which characterises Harris's method.

PREPARATION OF THE RETAINED CATHETER

A thin-walled wide-bore rubber catheter of size 22 French is employed. This is estimated by gauge and not by the maker's marking. A calibrator (size number 12F. gauge) is always passed to determine that there is no undue narrowing at any point throughout the lumen of the catheter, as actual diaphragm formation owing to faulty manufacture is sometimes detected.

After the catheter is passed into the bladder a second eye is cut about 3.75 centimetres ($1\frac{1}{2}$ inches) from the tip, and the end of the catheter is cut off transversely just beyond this new eye. The full calibre of the catheter is thus made available for drainage (fig. 1711).

Figure 1712 is a sectional view of the completed operation.

If, as occasionally happens, it is found that the catheter is too large to pass through the urethra into the bladder, no apprehension need be felt, as the catheter plays no part either in the control of hæmorrhage or in the urethral reconstruction. In these circumstances the catheter is omitted and suprapubic drainage is instituted. The bladder will be found to close rapidly after removal of the suprapubic drainage-tube.

TWO-STAGE PROSTATECTOMY WITH CLOSURE

The same plastic technique is employed in the two-stage operation. In the first stage a transverse incision is made two inches instead of one inch above the symphysis, and room is left by this means for a vertical incision downwards in the second stage. To accomplish this, a grooved director is insinuated along the sinus into the bladder. A knife is passed down the groove, with its cutting edge forwards. The tissues are divided from within outwards, care being taken to keep well clear of the symphysis. No attempt at excision of the fistula is made. Watertight closure of the bladder and abdominal wall is, of course, not so readily obtained in these cases. It is surprising, however, how little urinary leakage actually occurs.

POST-OPERATIVE CATHETER DRAINAGE

At the termination of the operation, and before the patient leaves the operating table, a few syringefuls of a solution of 1 in 4000 nitrate

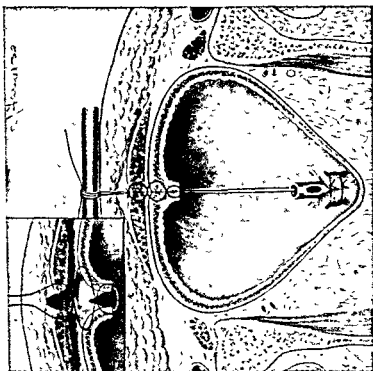


Fig. 1712.—SECTIONAL VIEW OF THE COMPLETED OPERATION SEEN FROM BELOW. THE THREE-LOOP SUTURE IS TIED, APPROXIMATING THE BLADDER MUSCLE, MAKING A VALVULAR INVERSION OF THE CUT EDGES, OBLITERATING THE SPACE OF RETZIUS AND CLOSING THE LOWER ANGLE OF THE INCISION IN THE APONEUROSIS. THE CATHETER IS TETHERED TO THE GLASS ROD LYING ON THE ABDOMEN. INSET: THE THREE LOOP, OR EXTENDED FIGURE-OF-EIGHT SUTURE PARTIALLY TIGHTENED. THE CATHETER SUTURE HAS BEEN OMITTED TO AVOID CONFUSION.

(*British Journal of Surgery.*)

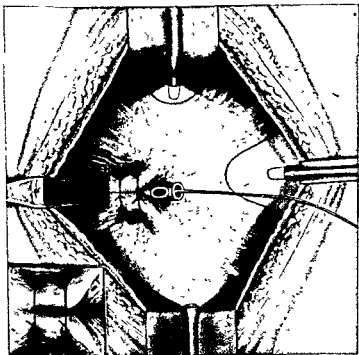


Fig. 1711.—ANTERIOR TRANSVERSE OBLITERATIVE SUTURES INSERTED. CATHETER WITH SILK WORM GUT TRANSFEXION SUTURE IN POSITION. PLASTIC OPERATION COMPLETE. (THE CATHETER IS PASSED INTACT AND THE TIP CUT OUT AFTER A SECOND EYE HAS BEEN MADE.) INSET: SAME STAGE BEFORE THE PASSAGE OF THE CATHETER. NOTE THAT THERE IS NO VISIBLE RAW SURFACE, THAT THE TRIGONE LIES ON A PLANE BELOW THE REST OF THE BLADDER BASE AND IS FIRMLY BEDDED IN POSITION, AND THAT THE LATERAL EDGES OF THE PROSTATIC RIM ARE DEEPLY INVERTED, THUS PARTLY RE-FORMING THE SIDE WALLS OF THE NEW PROSTATIC URETHRA.

(*British Journal of Surgery.*)

of silver are run backwards and forwards through the catheter to remove the blood clot which the catheter will have collected during its introduction. A wide-bore glass connection is then placed in the funnel end of the catheter and inserted into a sterilised (8-oz.) glass bottle containing sufficient sterile lotion to immerse the end of the glass connection. When the patient is returned to bed, the catheter is connected up in the usual way by a length of rubber tubing to a bottle at the bedside.

Irrigation beyond the amount necessary to ensure the free flow through the catheter is not permitted. It should be called for only at odd intervals, if at all, during the entire period of retention of the catheter, not more than half to one ounce of silver nitrate solution being employed at any one time.

Spasmodic and painful contractions of the bladder sometimes occur during the first few days of convalescence, especially in fat patients. This can generally be overcome or minimized by leading the rubber drainage-tubing from the catheter below instead of over the patient's thigh.

The catheter is retained in position until the tenth day after operation. It is removed by cutting across the silkworm-gut suture below the glass rod and flush with the skin. The hairpin-shaped remnant of silkworm-gut comes away with the catheter. Most patients are out of bed on the eleventh day.

POST-OPERATIVE HÆMORRHAGE

Post-operative hæmorrhage, reactionary or secondary, of sufficient severity to demand re-opening of the bladder is extremely rare and may, almost without exception, be regarded as evidence of incomplete or faulty technique. There was no case of primary hæmorrhage, and only one of secondary hæmorrhage in the last hundred operations reported by Harris.

It is axiomatic that no bladder should ever be completely closed when the bleeding has not been adequately controlled.

On this point there should be no room for errors of judgment.

An injection into the buttock of from one to two fluid ounces of whole blood, which need not be typed for this purpose, will be of value in the occasional case in which its use may be called for on account of the persistent formation of clots interfering with the continuity of drainage through the catheter, either before or after prostatectomy.

(F) TWO-STAGE PERINEAL PROSTATECTOMY (WINSBURY-WHITE'S OPERATION)

This surgeon has devised a technique for the operation which assures a complete reconstruction of the prostatic urethra. The success of the procedures advocated depends upon the use of the special instruments illustrated in figure 1713. I am indebted to Winsbury-White for the following description of the operation :

" I prefer gas and oxygen anaesthesia to any other. Shoulder rests must be fitted to the table so that they come much lower than those which are ordinarily fixed to an operation table. The perineum is brought over the end of the table, with a wide and broad sand-bag under the sacrum. The feet are then secured to the uprights so that the patient is in an exaggerated lithotomy position. The operation field is treated with antiseptic, the towels placed in position, and the prostatic tractor is passed per urethram and the blades opened. The scrotum is secured to the handle of the tractor by a length of gauze. The head of the table is tilted sharply downwards so that the perineum is directed towards the ceiling. A horseshoe incision is now made in the perineum commencing 3 cm. in front of the anterior anal margin, while the two limbs pass backwards midway between the ischial tuberosity and the anus, to the level of the posterior margin of the latter structure. The knife is then plunged into the ischio-rectal fossa at the level of the anterior margin of the anus, first on one side and then on the other. The index fingers follow the knife, in order to assure a line of cleavage which will lie behind the transversus perinei muscles. The resistance of these structures can be felt as the forefingers press forward. The skin flap is next dissected back and a silkworm-gut suture is passed through it near its anterior extremity. The free ends of this are secured with a small pair of artery forceps. The assistant makes traction through these while the central point of the perineum is divided. By gauze dissection the line of cleavage is identified between the rectum and the perineal muscular fibres which pass backwards to either side of the anal canal. The lateral strands of these muscles are divided, and by further gauze dissection and retraction forwards of the transversus perinei muscles the recto-urethralis muscle is clearly exposed.

It is convenient at this stage to place the rectal guide in position and to secure it by passing the two ends of the silkworm-gut stitch which has transfixed the skin flap through one of the holes near the outer end of the guide. By clamping the sutures close to the

under-surface of the latter, it becomes self-retaining in the rectal canal. The transverse perineal muscles are retracted forwards and the recto-urethralis muscle is divided transversely. By manipulating the outer end of the rectal guide the anterior limit of the rectum can be made out as it lies in relation to the prostate. Denonvillier's fascia is next divided transversely and the prostatic capsule is thus exposed. The self-retaining perineal retractor is now placed in position, and, in addition, the assistant uses anterior and posterior retraction. This results in a most excellent view of the whole of the under-surface of the gland.

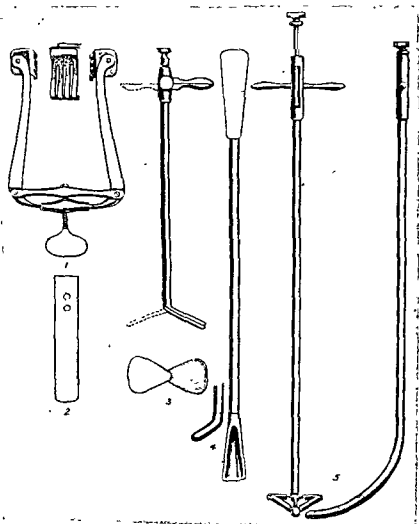


Fig. 1713.—WISSBURY-WHITE'S PERINEAL PROSTATECTOMY INSTRUMENTS.

- (1) The self retaining perineal retractor.
- (2) The self retaining rectal guide.
- (3) The bladder-neck tractor with the blades open and closed.
- (4) The urethral guide with its detachable beak and grooved attachment.
- (5) The prostatic tractor in the open and the closed positions.

It is now a simple matter to make a "T"-shaped incision (fig. 1714) in the prostatic capsule, and by blunt dissection to commence the line of cleavage that the enucleation with the finger will follow. The top limb of the "T" should run transversely about $\frac{1}{2}$ inch behind the membranous urethra, while the vertical limb passes backwards in the mid-line along the whole length of the under-surface. As the margins of the latter cut retract, a blunt dissector is inserted and a thickness of capsule is separated from the gland not less than $\frac{3}{16}$ inch in depth. This dissection is carried laterally on each side for $\frac{1}{2}$ inch.

By means of Young's boomerang needle, a traction suture is placed through each elevated portion of the prostatic capsule (fig. 1715). The

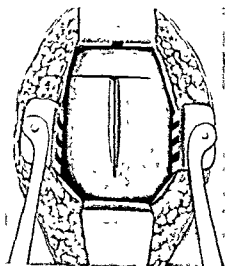


Fig. 1714.—THE "T" SHAPED INCISION IN THE PROSTATIC CAPSULE.

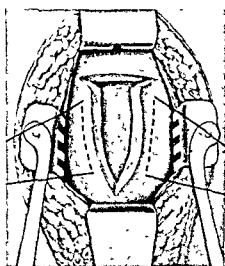


Fig. 1715.—THE PROSTATIC CAPSULE HAS BEEN SEPARATED FROM THE GLAND FOR $\frac{1}{2}$ INCH ON EITHER SIDE OF THE VERTICAL INCISION AND THE TRACTION SUTURES INSERTED.

sutures are placed parallel with, and $\frac{1}{4}$ inch from, the margins of the cut. Their free ends are secured by small artery forceps and twisted round the respective towel clips placed laterally to the field of operation. All retractors are now removed and the enucleation of the prostate is commenced with the index finger. When the prostate is freed except for its anterior and posterior attachments, the prostatic tractor is removed from the urethra. The gland is grasped with a special pair of forceps and drawn towards the surface. The anterior attachment of the prostate can now be identified as the urethra, and the posterior one as a broad fibrous band having a wide attachment to the under-surface of the vesical trigone and to the posterior margin of the internal urinary meatus. The prostate is carefully separated from both of these anchoring structures by cutting with scissors. By passing two

fingers deeply into the wound, the internal urinary meatus can be identified in its depth as a circular opening gripping the two digits as they pass into the bladder. The bladder-neck tractor is passed through this orifice and the blades opened (fig. 1716). The assistant exerts traction with the instrument, allowing the shaft to rest in contact with the pubic arch. The self-retaining perineal retractor is again placed in position and the flat-bladed Young's retractor is applied to the posterior part of the wound to keep the rectum well out of the way. This provides a splendid view of the under-surface of the bladder and the internal urinary meatus. On the former, spurting arteries are sometimes seen but are easy to deal with. But the chief importance of this exposure lies in the easy access obtained to the internal urinary meatus. The boomerang needle is inserted into the tissue of the bladder adjacent to this, $\frac{1}{4}$ inch from its margin, and round which it is made to pass. Two sutures $\frac{1}{2}$ inch apart are thus placed. Thread-holders are left fixed to their upper ends, and these are placed for the time being on the towels in the suprapubic region. All retractors including the bladder-neck instrument are now removed, and the urethral director is passed per urethram. The beak of the latter in the perineum is unscrewed and replaced by the grooved attachment. By applying a rake retractor to the superficial perineal muscles the anterior margin of the transverse cut in the prostatic capsule, and deep to it the margin of the divided urethra, are brought into view (fig. 1717). The boomerang needle is passed from without inwards, not only through these structures but also to include the superficial perineal muscles as well. In this way the sutures which pass through the urethra will also include a mass of overlying tissue of considerable strength. The needle is passed twice in this manner $\frac{1}{4}$ inch on either side of the mid-line, and when it presents in the groove of the director, the corresponding thread which has been passed through the bladder neck and which had been previously mounted in the thread-holder is engaged with the needle. No. 4 plain catgut is used. The two ends of each thread are left untied but clamped together by a small pair of artery forceps. The grooved attachment of the urethral guide is now unscrewed and the instrument is withdrawn from the urethra.

A No. 20 Charrière gum elastic catheter is passed per urethram into the bladder, being guided through the perineum with the fingers. The sutures are tied, the ends being left long, and held up by the assistant. The neck of the bladder and the urethra will now be found in close approximation without tension. A forefinger is then passed to one side of the suture line into the bladder, and by identifying the bladder neck

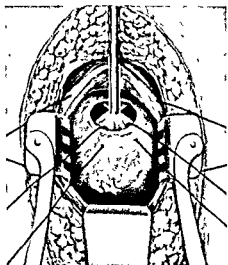


Fig. 1716.—THE BLADDER-NECK TRACTOR IS PULLING THE INTERNAL URINARY MEATUS WELL UP TOWARDS THE SURFACE AND SUITABLE RETRACTION IS PROVIDING A GOOD VIEW OF THE UNDER SURFACE OF THE BLADDER.

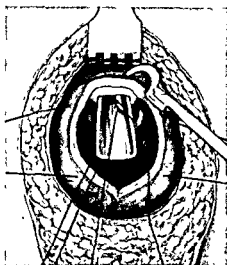


Fig. 1717.—WITH THE URETHRAL GUIDE IN POSITION, BY MEANS OF THE BOOMERANG NEEDLE, THE SUTURES THROUGH THE BLADDER NECK ARE DRAWN THROUGH THE STUMP OF THE URETHRA AND THE OVERLYING TISSUES.

a further suture can be passed through this structure and the perineal muscles in front. This is done first on one side and then on the other (fig. 1718). As a rule it will now be found that it is not possible for a finger to find its way into the bladder from the perineum. The two traction sutures which were passed through the capsule of the prostate before the gland was enucleated are tied at this stage. The anterior ends of each are first united by a reef knot and

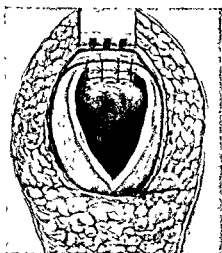


Fig. 1718.—THE NECK OF THE BLADDER IS SECURED TO THE STUMP OF THE URETHRA. THE ANTERIOR MARGIN OF THE INCISION IN THE PROSTATIC CAPSULE, AND THE OVERLYING PERINEAL MUSCLES.

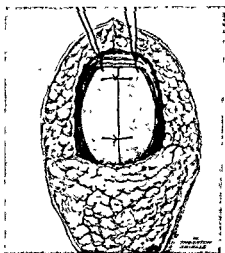


Fig. 1719.—THE VERTICAL INCISION IN THE PROSTATIC CAPSULE IS CLOSED AND THE CAPSULE IS SECURED ANTERIORLY TO THE TRANSVERSE PERINEAL MUSCLES.

then the posterior ends are tied in a similar manner. The bulk of the prostatic cavity is thus obliterated (fig. 1719). The anterior margin of the reconstructed prostatic capsule is then sutured to the transverse perineal muscles. In this way an extra support for the reconstituted floor of the bladder and posterior urethra is provided. A drainage-tube is placed down to the level of the outer surface of the prostatic capsule and the levatores ani are drawn together again by two strong catgut sutures. Interrupted silkworm-gut sutures uniting the skin margins complete the closure of the wound. The tube is stitched to the skin edge and the catheter tied in."

After-Treatment. The perineal tube is left undisturbed for one week and then gradually shortened until the fistula is closed. Generally there is some slight leakage of the urine through the perineum. The urethral catheter is removed at the end of seven days, the bowels are confined for four days, and the motion preceded by an injection of olive oil per rectum to soften any faecal accumulation. The bladder is washed through twice daily, the fluid passing in through the urethral catheter and out through the suprapubic tube. On removal of the former, irrigation is continued suprapubically. The patient is allowed up at the end of a fortnight and should be seated on a combined rubber ring and pan if any urinary leakage through the perineum is still occurring. When this has all ceased, the suprapubic tube is removed and the wound allowed to heal, after freshening its edges by the application of pure carbolic acid.

Complications. (1) Secondary hæmorrhage: When using his own technique, this has been found by Winsbury-White to be rare, but it responds to drainage from the field of operation by removing a few of the skin sutures to provide a ready exit for the clot through the perineum, and by irrigation of the bladder per urethram.

(2) Recto-urethral fistula: This may result from injury to the rectum while it is being stripped from the under-surface of the prostate, and may require a second operation to separate the rectum from the prostatic capsule in the region of the fistula. If injury to the rectum is observed during the operation, the latter should be abandoned and the prostate removed by the suprapubic route. This will prevent the formation of a fistula and will not increase either the length of convalescence or the risk of the operation.

(3) Post-operative obstruction of the bladder neck: This was noticed in only one case of Winsbury-White's series, and readily responded to dilatation by bougies.

(4) Post-operative shock and infective complications: These are found to be much less than with two-stage suprapubic prostatectomy.

(G) PERURETHRAL RESECTION (McCARTHY'S OPERATION)

Perurethral resection may be carried out as a one-stage operation or be preceded by a period of catheter drainage or suprapubic drainage, or both, according to the general condition of the patient and the state

of his renal function. Some urologists perform a cystotomy immediately after the resection in order to ensure double drainage and a freedom from the risk of infection which is ever present and which necessitates constant personal supervision after a one-stage operation. Perurethral resection is indicated in prostatic fibrosis, prostatic bar (fig. 1720) and certain types of median lobe enlargement of the gland.



Fig. 1720.—PROSTATIC BAR.

Preparation. Two vegetable laxative pills are given two days before, and an enema administered early on the morning of the operation.

Anæsthetic. Gas and oxygen preceded by atropine, $\frac{1}{100}$ gr., and some preliminary narcotic such as intra-rectal avertin or intravenous evipan.

Position. The patient is placed in the lithotomy position, care being taken to ensure that several thicknesses of cotton wool are inserted between the calves of the legs and the lithotomy poles.

Instruments. The special instruments necessary consist of: (1) McCarthy's prostatic electrotome (fig. 1721) (2) Genito-urinary cutting diathermy machine with footswitch. (3) Irrigating stand. (4) A set of Lister's steel sounds. (5) A No. 12 and No. 14 English coude gum elastic catheter. (6) Sterile water at 110° Centigrade, which is essential for good cutting, as disinfectant solutions diffuse the current.

Operation. A lead belt is placed round the patient's waist and connected to one terminal of the diathermy machine, a pad being inserted between the buckle and the skin to prevent sparking. 20 cc. of coagulen-ciba are injected into one buttock, the external genitals are painted with 3 per cent picric acid in spirit, and the penis is isolated with sterile towels.

The operating table is screwed up to its fullest extent. The sheath of the electrotome, well lubricated with lubafax, and with obturator in position, is gently passed down the urethra. Should any obstruction be encountered at the bladder neck the instrument must be withdrawn and dilatation carried out with increasing sizes of steel sounds up to 28/32 Charrière, which will allow the electrotome to be passed. The obturator is removed, any residual urine present allowed to escape, and the bladder washed out with sterile water by means of 6-oz. bladder syringes until the return flow is perfectly clear.

The cords from the battery are clipped on to the telescope of the loop electrode carrier and the light is tested. The carrier with retracted loop is inserted into the sheath. The inflow-cock on the sheath is connected to the irrigating stand and a piece of rubber tubing is attached to the outflow-cock and left hanging in a pail.

The cable from the diathermy machine is fitted to the electrotome and an examination of the prostate begun. The most important step of this examination consists of the urethroscopic view of the bladder neck, where the enlarged median lobe of the prostate or prostatic bar which is to be removed is seen rising up from the floor (fig. 1722).

By withdrawing the instrument into the posterior urethra an estimate can be made of the amount of intravesical enlargement of the



(a) THE SHEATH is made of "Bakelite," a heat- and acid-resisting insulating compound. A coned chamber with locking screw A, inlet-cock K and outlet-cock B are fixed to the proximal end. The other end C is cut away so that the loop electrode is free to engage in the prostate.

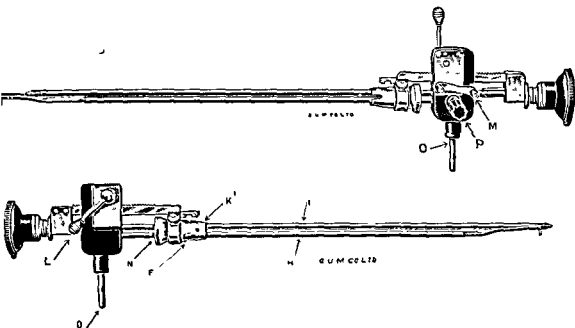


(b) THE OBTURATOR consists of the beak D hinged to the two expanding segments E E. Two rods connect the beak and segments to the cone F and milled screw head G respectively. When the milled screw head G is turned clockwise the segments E E expand and tilt the beak to an angle of 45°. The segments are recessed so that the edges of the sheath are protected.

Fig. 1721A.—McCarthy's PROSTATIC ELECTROTOME.

(a) Sheath.

(b) Obturator.



(c) THE ELECTRODE CARRIER consists of the conical fitting F, the guide tube for the electrodes H and the water inlet tube I. The water inlet tube communicates with the inlet-cock K on the sheath by way of an opening bored into the cone fitting at K' which opening is so arranged that it comes into exact opposition with the inlet-cock when the electrode carrier is locked to the sheath. A rack is firmly screwed on to the cone on its outer side and engages with an electrode carrier by means of a pinion and handle L. The rack terminates in the shape of a block which supports the telescope and prevents rotation of the latter. By means of a clamping ring N the joint in the cone can be made watertight. The loop and diathermy electrodes are interchangeable on the electrode carrier. They are held in position by clamping screw P. The cable from the endothermy cable is connected to the pin Q on the electrode carrier.

Above the clamping screw P is a small hinged lever M. This lever abuts against a ridge on the telescope, and moves it outward near the end of the cut. This device has the effect of keeping the active end of the loop electrode at a safe distance from the lamp and telescope.



(d) THE CUTTING LOOP ELECTRODE.



(e) THE BUTTON ELECTRODE.



(f) LOUGHNANE'S NICKEL-PLATED HOOK, for removal of resected portions of prostate.

Fig. 1721B.—MC CARTHY'S PROSTATIC ELECTROTOME.

- (c) Electrode carrier.
- (d) Cutting loop electrode.
- (e) Diathermy electrode.
- (f) Loughnane's hook.

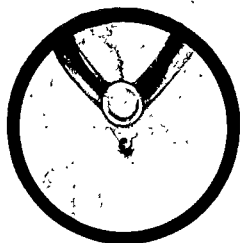


Fig. 1727.—BUTTON ELECTRODE APPLIED TO BLEEDING VESSEL.

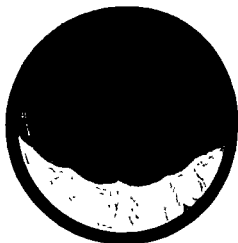


Fig. 1728.—URETHROSCOPIC VIEW OF BLADDER NECK AFTER PERURETHRAL RESECTION.

urethra and the button electrode applied to these, the strength of current having first been reduced from dial setting 5 to 2 (fig. 1727).

Hæmorrhage is especially apt to occur when the cuts have been made too quickly. At times a spurting vessel will become evident when the inflow of water is temporarily turned off, and this should always be done in case one is overlooked.

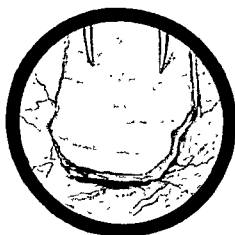


Fig. 1729.—LOUGHNAN'S HOOK ABOUT TO REMOVE PROSTATIC FRAGMENT.

Any ragged edges on the bladder neck (fig. 1728) or in the posterior urethra should also be treated with the button electrode.

When every bleeding point has been sealed and the return flow of water is clear, the whole instrument is pushed on into the bladder and a search made for any pieces of prostate which have failed to adhere to the cutting loop. Should one be found, an attempt is made to wash

it out through the sheath, using the 6-oz. bladder syringe, but should this fail the electrode carrier is removed from the sheath and the button electrode replaced by Loughnane's hook (see fig. f, 1721B). The fragment of prostate is caught (fig. 1729) and removed through the sheath, which is then withdrawn, and a catheter, size 14 English, tied in in the usual way.

The bladder is again washed out through the catheter to ascertain that it is in position and that all bleeding has stopped.

After-Treatment. Morphia $\frac{1}{4}$ gr. is given when the patient has recovered from the anæsthetic, and may be repeated in six hours, after which empirin compound 10 grs. should be sufficient to allay any discomfort which may be present.

The bladder is washed out four-hourly with oxycyanide of mercury 1 in 8000 through the catheter, which is removed when the urine is free from hæmorrhage, i.e. in approximately three to four days' time.

(H) SUPRAPUBIC RESECTION (AUTHOR'S METHOD)

Suprapubic resection of the prostate by means of the diathermy cutting current may be carried out as an alternative to McCarthy's perurethral resection, and is indicated in similar conditions. By its means the greater part of the median lobe and, if necessary, portions of the lateral lobes can be removed by direct open operation and all bleeding checked at the time. The method thus resembles the diathermic removal of bladder growths.

Preliminary catheter drainage can be carried out according to the general condition of the patient and the state of his renal function.

Preliminary treatment, preparation of the patient, his position and anæsthetic are the same as for suprapubic cystotomy.

Instruments. The special instruments necessary consist of: (1) A series of cutting loops mounted at an angle of 45° on insulated bakelite handles. (2) Prostatic forceps. (3) Genito-urinary cutting current diathermy machine with footswitch.

Operation. A lead plate covered with gauze soaked in salt solution is placed under the patient's buttocks and is connected to one terminal of the diathermy machine, a pad being inserted between the buckle and the skin to prevent sparking. 20 cc. of coagulen-ciba are injected into the buttock and 3 per cent picric acid is applied to the skin of the lower abdomen, external genitals, and the front and inner aspect of the thighs, special care being directed to the glans penis with retracted prepuce.

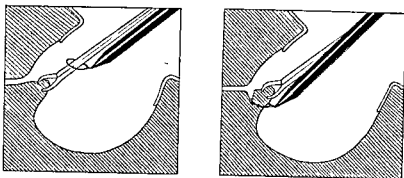


Fig. 1730.—TRANSVESICAL RESECTION OF PROSTATE.

The bladder is opened after passing a catheter and washing out and distending the viscus, as described under "Suprapubic Cystotomy" (see page 2975).

All retractors and instruments are removed, the patient is placed in the Trendelenburg position and Morson's self-retaining illuminated retractor is inserted. The lights are switched on, the bladder mopped dry with sterile swabs, and a visual inspection of the prostate begun.

The intravesical projection of the median lobe or the posterior margin of a fibrous prostate is seized with the special prostatic forceps passed through the cutting loop and is withdrawn as far as possible into the cavity of the bladder (fig. 1730). By means of the cutting loop mounted on a bakelite handle, which is connected by an insulated cable to the other terminal of the diathermy machine, this portion of the prostate is excised (fig. 1730) and any spurting vessels seized with

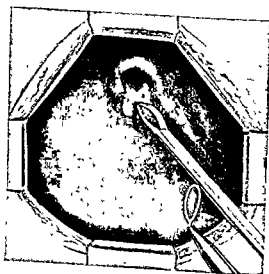


Fig. 1731.—SUPRAPUBIC RESECTION OF PROSTATE.
ARREST OF BLEEDING.

the prostatic forceps. By bringing the diathermy loop in contact with the forceps and switching on the current momentarily, the vessels are effectively sealed by coagulation (fig. 1731). If necessary, a further portion of prostate is grasped with the special forceps and the procedure repeated.

When a requisite amount of the gland has been removed and all spurting vessels are sealed, any residual oozing is checked by the application of a button electrode (see fig. 1664), the current being changed from "cutting" to "diathermy." Much experience is necessary to gauge the extent of the prostatic resection. If too little tissue is removed, obstruction persists and healing of the wound will be either considerably delayed or even prevented.

The bladder is closed round a Winsbury-White tube and the operation completed as described under "Closure of the bladder with drainage" (see page 2978). Picric acid and dressings are applied to the wound.

After-Treatment. This is the same as for a one-stage prostatectomy, and similar complications may arise.

(I) SUPRAPUBIC RESECTION (IRWIN'S METHOD)

The preliminary treatment, preparation of the patient, the position and anæsthetic are the same as for suprapubic resection.

The bladder is exposed by a vertical incision $2\frac{1}{2}$ inches in length, and opened. After pushing the finger through the internal urinary meatus into the prostatic urethra, the internal sphincter is mobilised posteriorly and divided.

Instrument. The special instrument necessary consists of Irwin's clamp incisor (fig. 1732), which is about eight inches long, has an outer or handle portion with a self-releasing rack and an inner portion consisting of a clamp and blade. The inner end for clamping and cutting the mobilised part of the sphincter has flat serrated jaws, each of which is deeply grooved down its centre. When the clamp has been applied, the blade is pushed down the grooves to the end of the instrument. In this way the internal sphincter is not only divided, but thoroughly crushed on each side of the prostatic urethra are packed with gauze with a view to keeping the opening dilated, incision. After division of the sphincter, the internal meatus and adjacent parts of and the bladder is closed in the usual way with drainage. Irwin has performed his operation in over thirty cases of stenosis of the bladder neck with excellent results.

MALIGNANT GROWTHS OF THE PROSTATE

Malignant disease of the prostate occurs in the form of carcinoma or sarcoma, of which the former is infinitely more common.

(A) *Carcinoma of the Prostate* is most commonly seen between the ages of 50 and 70 years, and, if untreated, usually causes the death of the patient within three years. It is usually of the spheroidal-celled variety, and can be divided into the soft (medullary) and hard (scirrhus) types according to the amount of fibrous tissue present, the latter being the more common.

Three clinical types are found: (1) that in which an apparently innocent enlarged prostate is removed by operation and found on microscopic section to contain a nodule of carcinoma; (2) a more rapidly spreading type which later infiltrates the surrounding structures, spreading forwards and upwards into the bladder, backwards into the

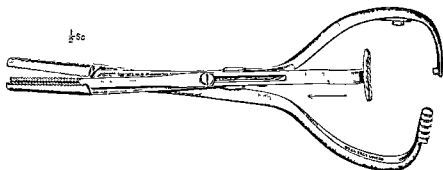


Fig. 1732.—IRWIN'S CLAMP INCISOR.

rectum, and outwards into the pelvic cellular tissue and glands; (3) a rare variety in which a small circumscribed focus of carcinoma exists in an otherwise normal prostate, giving rise to early metastases, chiefly in the bone-marrow of the vertebræ, the femur and the humerus, and sometimes causing spontaneous fracture in the latter two bones.

Symptoms and Signs. In early cases the symptoms resemble those of other varieties of prostatic obstruction, and consist of frequency of micturition, a diminished stream, and difficulty in starting the act. Chronic retention, with or without overflow, may occur and attacks of acute retention supervene. Hæmaturia is unusual as the carcinoma usually begins in the posterior part of the gland. Pain is a marked feature, and consists of perineal and suprapubic aching, and spasmodic attacks referred to the end of the penis which are unrelieved by micturition. In the later stages intense pain extending down the back of one or both legs may occur from involvement of the sciatic nerves. The urine contains pus when ulceration of the growth into the bladder takes place. Marked cachexia occurs early, and is of the typical cancerous variety.

Diagnosis. This is made by a consideration of the history, symptoms, routine examination, and in some cases by cystoscopy. In type 1, this will lead to a diagnosis of an apparently innocent hypertrophy, and the true state of affairs be revealed only by post-operative microscopy of the gland. In type 2, when the disease is moderately advanced, a rectal examination will make the diagnosis clear. The prostate feels stony hard, enlarged, and uniformly nodular, though at times only one densely hard area can be palpated. The definition of the upper border and lateral margins is preserved and the rectal wall is freely mobile. In an advanced case the definition of these borders becomes obliterated, and irregular projections can be felt extending outwards into each side of the pelvis and upwards along the *vesiculæ seminales*.

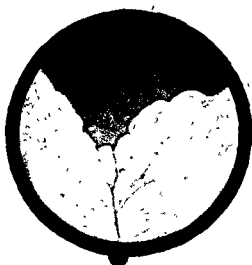


Fig. 1733.—MALIGNANT PROSTATE: CYSTOSCOPIC VIEW OF JUNCTION OF LATERAL LOBES.

The rectal wall is adherent to the gland. In some cases of enlargement, hard glands can be felt in the pelvis. In type 3, where spontaneous fracture of a long bone has taken place, the diagnosis is often difficult, and although no urinary symptoms have occurred, a rectal examination must never be omitted and may reveal a single ill-defined hard plaque in one portion of the gland.

Cystoscopic examination is indicated in type 1, and demonstrates the characteristics of an enlarged prostate. In type 2 it is better omitted on account of the likelihood of severe hæmorrhage, but, if performed, may demonstrate irregular projections on the prostatic margin, which, in places, have ulcerated (fig. 1733). In other cases the appearances may suggest a malignant growth involving the prostate and adjacent bladder wall, surrounded by irregular puckering of the mucous membrane and bullous œdema. In type 3 the findings will be negative.

Treatment. Unfortunately in the great majority of cases the disease is inoperable when first seen, though the outlook is more hopeful in cases of type 1, in which malignancy is only discovered during routine microscopic examination of the gland after removal.

When once a definite diagnosis of prostatic carcinoma has been made, most urologists are agreed that radical treatment is not only out of the question, but is definitely harmful on account of an almost immediate dissemination which occurs shortly after the operation. The treatment of undoubted carcinoma is therefore entirely palliative and falls under four headings: (1) Medical; (2) Instrumental; (3) Surgical; and (4) Radiological.

(1) *Medical.* Pain due to nerve involvement must be treated at first by empirin compound and later by hypodermic injections of heroin or morphia.

(2) *Instrumental.* This is indicated for retention, when soft catheters should be used to prevent bleeding. Perurethral resection and the cutting of a deep groove through the median prostatic lobe may be carried out and if necessary repeated as a temporary alternative to cystotomy, though hæmorrhage is sometimes a formidable complication and dissemination of the growth may follow.

(3) *Surgical.* Permanent suprapubic cystotomy is indicated in the majority of cases, especially in those in whom catheterisation is impossible or is followed by clot retention, and in those in whom perurethral resection has failed to relieve the obstruction. Unfortunately this operation does not relieve the painful spasms due to nerve involvement which are a characteristic of the disease.

(4) *Radiological.* Deep X-rays should be used in all cases of type 1, in which a focus of carcinoma is discovered after removal of the gland. Radium is indicated as a palliative treatment in inoperable cases. The needles are best inserted into and around the prostate, using the perineal approach. Radon needles have been introduced from the vesical aspect of the gland through an operating cystoscope. Deep X-ray therapy has at times been followed by considerable shrinkage in the size of the gland and relief of the urinary obstruction.

(B) *Sarcoma of the Prostate.* This disease is rare compared with carcinoma, but is occasionally seen in children between 3 and 10 and in adults between 20 and 40 years. The characteristic symptoms are those of obstruction, resulting in early retention of urine.

Rectal examination reveals a smooth elastic tumour, which may be of considerable size, in the region of the prostate gland. Pain and hæmaturia are rare. Treatment is always palliative, and consists of suprapubic cystotomy, though the patient may die from general dissemination before retention has occurred.

CHAPTER VI

DISEASES OF THE PENIS, TESTIS, SCROTUM AND ADNEXA

DISEASES OF THE PENIS

MEATAL STENOSIS

THE external urinary meatus is the narrowest part of the male urethra, but in the normal individual should admit a bougie or steel sound of size 25° to 30° Charrière. Any marked diminution of the opening may cause symptoms of back pressure on the whole of the urinary tract as serious as those of obstruction at the bladder neck due to enlargement or fibrosis of the prostate gland.

Meatal stenosis (fig. 1734) is congenital in origin and should be one of the first things to be looked for in children and young adults complaining of obscure urinary or genital symptoms.

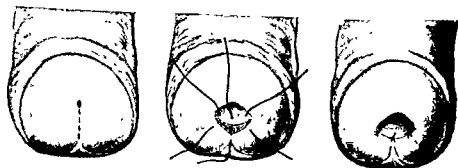


Fig. 1734.—PIN HOLE EXTERNAL URINARY MEATUS AND MEATOTOMY.

Symptoms and Signs. These depend entirely on the degree of stenosis and, except for a diminution in the size of the stream, are due to the presence of complications resulting from back pressure and infection, or a combination of the two.

Treatment. In young children all that may be necessary is to dilate the opening with graduated meatal dilators, but in adults meatotomy is required. This operation is usually performed under local anæsthesia, a small quantity of 1 per cent novocaine being

injected into the glans between the frenum and the meatus. With a small-bladed scalpel the meatus is divided on its floor in the middle line until a No. 30° Charrière meatal dilator can be easily introduced. Two or more No. 0 catgut sutures are inserted (fig. 1734) which approximate the mucous membrane of the urethra to the skin of the glans. The introduction of these sutures constitutes the most important step in the operation, not so much in that they check hæmorrhage, but because they prevent subsequent contraction.

HYPOSPADIAS

This congenital defect is due to failure in the formation of the floor of the urethra, which may open at some point on the under-surface of the penis proximal to the normal position of the meatus. Three varieties are described—glandular, penile, and perineal—according to the situation of the opening. The posterior urethra with its sphincters is fortunately never involved.

(1) *Glandular Hypospadias*. In this, the most common type, the urethra opens on the under-surface of the glans. It is due to failure of the invagination of the surface epithelium, which forms the glandular part of the urethra, to join the genito-urinary sinus forming the penile portion. Usually but little inconvenience in coitus and micturition is caused, and no treatment is required other than intermittent dilatation of the opening which is usually contracted. In some cases, however, meatotomy is indicated.

(2) *Penile Hypospadias*. In this variety the opening of the urethra is in the body of the penis, or at the junction of the penis and scrotum, and is due to failure in development of the urogenital sinus and corpus spongiosum. The penis is ill-developed and the corpus spongiosum is represented by two narrow fibrous bands separated by a moist red furrow. These two bands cause the penis to be bent downwards, thereby preventing erection. There is usually a lack of development of the glans and corpora cavernosa. Difficulty in micturition and coitus is the rule and the latter is often impossible. Eczema of the scrotum occurs as the result of inability to project the urinary stream.

Treatment. Operative treatment is usually unsatisfactory, and should only be advised to prevent wetting of the clothes during micturition with consequent excoriation of the skin, and in order to facilitate

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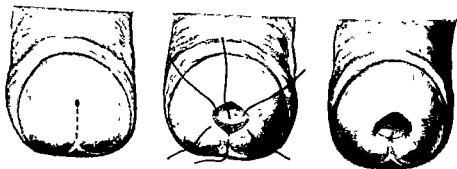


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Treatment. Operative treatment is usually unsatisfactory, and should only be advised to prevent wetting of the clothes during micturition with consequent excoriation of the skin, and in order to facilitate

the ventral surface of the penis. Two small incisions, each an inch long are made at each extremity of the ventral flap. The flaps are dissected outwards on either side of the central flap of both penis and scrotum (fig. 1735 II).

A small rubber catheter of size No. 12° Charrière is inserted into the urethral opening and the latter split vertically. The catheter is next bent downwards so that the central flap of the prepuce is in accurate apposition with the lateral flaps, the lateral raw areas being thus brought into similar apposition.

Care must be taken to ensure that the urethra is not twisted at the apex of the angle thus formed between the flaps. This position is maintained by suturing the lateral flaps with hair stitches after placing a fine drainage-tube into the urethra. The surfaces of the double flap on either side (fig. 1735 III) are then sutured together.

Figure 1735 IV is a cross-section showing the new urethra, the roof of the scrotum, the central strip of penile mucous membrane, and the preputial graft on the anterior aspect of the scrotum.

The catheter is retained by stitching it to the scrotum. The catheter is still further fixed to the scrotum by additional sutures. The catheter and sutures are removed after a week, and the patient's hands are kept clean to prevent interference with the healing process.

Stage 4. Two vertical incisions are made, each a quarter of an inch from the outer side of the central flap. The flaps are united by a transverse one just distal to the central flap. The flaps are dissected up, whereby the penis is detached from the scrotum. The raw area thus formed is closed by interrupting the edges of the flap which has been dissected up. The middle line on the under-surface of the penis is sutured to the middle line on the under-surface of the scrotum thus gained for the new urethral floor (figs. 1735 V and VI).

Stitches are removed on the eighth day. The new urethra is ensured by the intermittent passage of the catheter.

(3) *Perineal Hypospadias.* This variety of the defect represents the extreme grade of the deformity. It is characterized by a cleft scrotum, undescended testicles, and a clitoris which may make the operation a difficult matter. The urethra opens in the perineal space, and excoriation of the skin is present. The patient is unable to urinate out in the squatting position and coitus is impossible.

Treatment. These cases are best left alone owing to the almost insuperable difficulties of any operative procedure and the universally bad results obtained.

EPISPADIAS

In this deformity, the urethra lies on the upper surface of the corpora cavernosa and opens on the dorsum of the penis. The cause is difficult to explain. It has been suggested that it may be due to torsion of the penis in early intra-uterine life, causing the under-surface to lie uppermost. As in hypospadias, three degrees are described: *glandular, penile, and complete.* The complete is the most common, and is usually associated with a rudimentary penis, represented by the glans only, and is often accompanied by ectopia vesicæ.

Symptoms and Signs. In both penile and complete types of epispadias incontinence of urine is present, causing continual dribbling of urine and eczema of the surrounding parts. The penis is bent upwards and coitus is difficult or impossible.

Treatment. As in hypospadias, this consists of a preliminary operation in which all bands and adhesions are divided, and a second operation in which the urethra is roofed over by means of flaps. In the more severe varieties of epispadias, incontinence of urine persists after the operation.

PHIMOSIS AND ITS COMPLICATIONS

Phimosis, or narrowing of the opening of the foreskin, may be congenital or be acquired in later life by repeated attacks of inflammation of the glans (balanitis), of the under-surface of the prepuce (posthitis), or of a combination of the two (balano-posthitis). Congenital phimosis is always associated with some degree of stenosis of the external urinary meatus, and it is of extreme importance that this should be recognised and dealt with at the same time. Phimosis and meatal stenosis may give rise to many complications, and it is usually one or other of these which first attracts attention and not the causal condition.

Symptoms and Signs.

- (1) Inability to retract the foreskin.
- (2) Abnormal length of the foreskin.

the ventral surface of the penis. Two small incisions, each an inch long are made at each extremity of the vertical line. The flaps are dissected outwards on either side of the line, both penis and scrotum (fig. 1735 n).

A small rubber catheter of size No. 12 is inserted into the urethral opening and the latter split vertically. The catheter is next bent downwards so that the flaps of the urethral membrane are in accurate apposition. The lateral raw areas being thus brought together.

Care must be taken to bring the flaps together at the apex of the angle. This position is maintained by hair stitches after the flaps are turned over the surfaces of the penis.

Figure 1735 n shows the flaps brought together and the central incision prepared.

the prepuce
is smeared
the procedure can

performed easily and painlessly.

In other cases circumcision should be performed, and if necessary the meatus dilated or enlarged by meatotomy (see page 3020).

Circumcision. The success of this operation depends on the removal of all the mucous under-surface of the prepuce to within a quarter of an inch of its attachment just behind the corona glandis, and as far as possible of the skin forming the outer aspect of the prepuce as consistent with the removal of the phimotic portion. In this way enough of the foreskin is left to reach a point midway between the corona glandis and the meatus, which allows for erection without the slightest tension on the suture line.

Technique. The operation is carried out under general anaesthesia. Three per cent picric acid in spirit should be applied to the parts including the glans and the under-surface of the prepuce if this can be retracted.

The foreskin is retracted somewhat until the tip of the glans is exposed, and artery forceps are clipped on to the edge of the prepuce on either side of the mid-line on the dorsum of the penis, while

third pair is clipped on to the ventral aspect near the frenum (fig. 1736).

With a pair of blunt-pointed scissors the prepuce is slit to within a quarter of an inch of the corona, care being taken not to pull too tightly on the artery forceps. From this point two lateral cuts are made which encircle the glans, passing outwards, downwards and forwards, and which meet at the ventral aspect of the prepuce near the frenum, where the third pair of artery forceps has been placed. The skin is next retracted and the remains of the mucous inner layer of the prepuce trimmed to within a quarter of an inch of the corona.

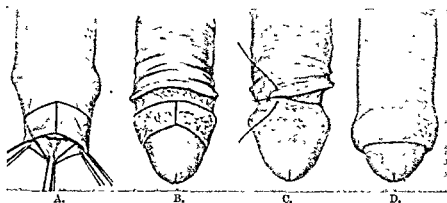


Fig. 1736.—CIRCUMCISION. A. LINE OF PREPUTIAL INCISIONS. B. OUTER LAYER OF PREPUCE REFLECTED, AND LINE OF INCISION OF INNER LAYER. C. STITCHES BEING INSERTED. D. FINAL APPEARANCE.

All bleeding points are picked up and ligatured with fine catgut and the skin united to the preputial fringe with interrupted sutures of No. 0 catgut. When correctly performed, the skin can be rolled forwards over the suture line and will cover at least one-half of the glans.

A strip of ribbon gauze, soaked in paraffin and flavine (1 in 1000), is applied to the wound, and this is covered by a loose piece of dry gauze.

Stitches are not removed but are allowed to separate naturally.

Paraphimosis. This complication of phimosis may occur when the prepuce, after retraction behind the corona, cannot be brought forward. Venous congestion soon brings about swelling and congestion of the glans, and if the condition is not quickly relieved, the constricting band will ulcerate through, with spontaneous freeing of the strangulated glans.

Owing to its rich blood supply, sloughing of the glans very rarely occurs.

- (3) Difficulty in getting the foreskin forwards, even if it can be retracted comparatively easily, or *paraphimosis* in which, after retraction, it is impossible to bring it forward at all.
- (4) Marked adhesions between the foreskin and the glans penis.
- (5) Inflammation of the glans and under-surface of the prepuce (balano-posthitis), and of the urinary and genital tracts.
- (6) Retention of secretion (smegma) or the formation of calculi under the prepuce.
- (7) Difficulty and pain on micturition, or retention, with resulting back pressure effects on the whole urinary tract, such as trabeculation of the bladder, hydro-ureter and hydro-nephrosis.
- (8) Incontinence of urine.
- (9) Hernia and rectal prolapse from straining.
- (10) Sexual excitement—masturbation and its sequelæ.
- (11) Difficulties in coitus.
- (12) Malignant disease.

Treatment. When slight adhesions exist between the prepuce and the glans, these may be separated by a probe, the parts smeared with vaseline, and the foreskin retracted daily until the procedure can be performed easily and painlessly.

In other cases circumcision should be performed, and if necessary the meatus dilated or enlarged by meatotomy (see page 3020).

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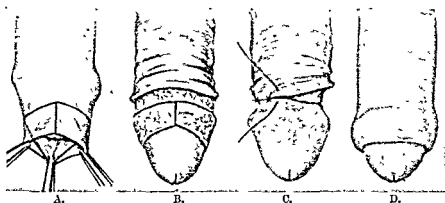


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Owing to its rich blood supply, sloughing of the glans very rarely occurs.

Treatment. In early cases an attempt should be made to reduce the paraphimosis. Bandages soaked in cooling lotion should be firmly applied to the glans for a few minutes to produce vasoconstriction and to reduce the swelling. The skin of the penis is grasped between the index and middle fingers of each hand, and steady backward pressure made by the two thumbs (fig. 1737). Should this fail, an anæsthetic is given and reduction again tried after puncturing the oedematous tissues in several places with a tenotomy knife.



Fig. 1737.—REDUCTION OF A PARAPHIMOSIS
(After Wilson.)



Fig. 1738.—CARCINOMA
OF PENIS, REMOVED BY
PARTIAL AMPUTATION.
(Author's case.)

If this is also unsuccessful, the constricting band must be completely divided by means of a sharp scalpel, after slitting up the prepuce on the dorsum of the penis until it is reached. The parts should be bathed in boracic lotion for several days until all inflammatory swelling has subsided, when a second anæsthetic is given and circumcision is completed.

NEW GROWTHS OF THE PENIS

Innocent. These are papillomata, and may be hard or soft, the latter being the more common.

Hard Papillomata. These are warts and in no way differ from those seen in other parts of the body. When they occur in elderly men and

are irritated or left untreated they are liable to develop into carcinoma. Usually they are single and occur on the prepuce or glans penis.

Soft Papillomata. These may be associated with gonorrhœa or retained secretions due to phimosis, or may occur independently without obvious cause. Usually they are multiple and occur on the deep surface of the prepuce behind the corona or on the glans. They are pedunculated or sessile, bleed easily, and may have a foul secretion. The inguinal glands are often enlarged.

Treatment. Both varieties should be excised, and circumcision performed if phimosis is present. In elderly men microscopic examination of the base of the papilloma should always be carried out.

Malignant. These are carcinomata, either squamous-celled arising from the superficial epithelium, or glandular arising from the sebaceous glands situated at the corona. The former are more common, but the latter more malignant. Carcinoma occurs in elderly people over fifty years of age, and is commonly associated with phimosis, and for this reason is usually discovered only after it has been present for some time. Other predisposing causes are lack of cleanliness, balanoposthitis, venereal sores, papillomata, and chronic superficial balanitis. The latter condition, sometimes referred to as *eczema of the glans* or *Paget's disease of the penis*, is usually recognised by white patches resembling chronic superficial glossitis, or occasionally by easily bleeding raw red patches where the epithelium has been shed and causes an increasing degree of phimosis. Cracking and bleeding of the skin may occur if the prepuce is forcibly retracted.

Carcinoma most frequently begins on or just behind the glans penis on the under-surface of the prepuce as a hard sessile warty growth on an indurated base, and is slow to ulcerate. When this occurs, the usual crateriform ulcer is formed with undermined prominent edges, indurated base, and accompanied by a foul secretion. First it is limited to the surface of the penis by the tough fibrous capsules of the corpora cavernosa and corpus spongiosum, but when these have been invaded, the spread is more rapid, sometimes with formation of secondary nodules separated from the primary growth, and occasionally accompanied by the formation of a fistula from ulceration into the urethra (fig. 1738).

The superficial and deep inguinal glands are affected early, but for a time the enlargement is only of an inflammatory nature. Later, with

spread of the disease to the body of the penis, the iliac glands become involved.

Symptoms and Signs. Owing to the presence of phimosis the first thing to be noticed in an elderly man is a discharge which later becomes foul and blood-stained. A hard lump can be felt under the prepuce which calls for circumcision as soon as possible, to ascertain the exact condition of the glans. In cases in which the foreskin can be retracted, the characteristic hard nodular growth or foul ulcer, both on a hard base, will be seen and the diagnosis should present no difficulty.

Treatment. This may be by the insertion of radium needles, by partial amputation, or by complete amputation. In all early cases, and in a definite percentage of later ones, the best results are undoubtedly obtained by the use of radium (see page 1612).

In some cases of carcinoma in which extension of growth has occurred into the urethra, and in which nodules can be felt in the corpora cavernosa, partial amputation offers the best hope of cure.

In advanced cases in which extensive involvement of both the corpora cavernosa and the corpus spongiosum has taken place, complete amputation is necessary for the eradication of the disease.

In all cases, the glands in both groins, whether palpable or not, must be regarded as potentially malignant and treated as such, either by the application of radium plaques (see page 1614), or by block dissection. Stanford Cade claims that treatment of the glands by radium is by far the more satisfactory method. If block dissection is employed, the entire lymphatic field, if possible, should be removed in one continuous piece.

Partial Amputation. Pre-operative Preparation. This consists of a perineal shave and the painting of the external genitals with 3 per cent picric acid in spirit the day before the operation.

Anæsthesia. A general anæsthetic is essential, and gas and oxygen, preceded by intra-rectal avertin or intravenous evipan, is advised.

Operation. The patient is placed in the dorsal position and the external genitals are painted with 3 per cent picric acid in spirit. Mackintoshes and towels are clipped in position and a tourniquet applied at the peno-scrotal junction.

The exact incision depends to some extent on the position of the

growth. As a rule a long ventral flap, whose width is equal to half the circumference of the penis, and whose length is equal to the diameter, should be employed. In addition, a short dorsal flap about half an inch long is made (fig. 1739). The flaps are dissected back to their bases, a fine scalpel is introduced between the corpus spongiosum and the corpora cavernosa, and about three-quarters of an inch of the urethra is isolated and cut across distally. The corpora cavernosa are divided circularly at the base of the flaps by means of a needle activated by the diathermy cutting current, or by a knife after transfixion and ligature with No. 2 chromicized catgut.

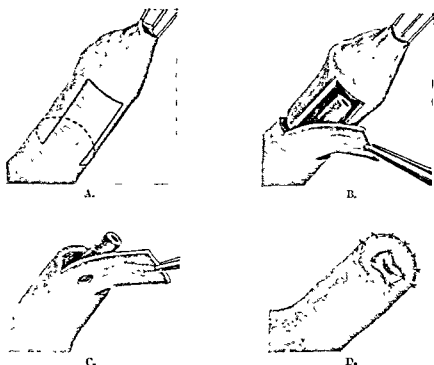


Fig. 1739.—PARTIAL AMPUTATION OF THE PENIS.

Ligatures are placed separately on the dorsal vessels of the penis, the tourniquet is removed, and any bleeding points are picked up and ligatured.

A small circular incision is made near the base of the long ventral flap, the urethra pulled through it, and the two flaps sutured together on the dorsum of the penis, adequate space being left between the stitches to allow for oozing of blood from the erectile tissue of the corpora cavernosa, which is frequently a troublesome complication.

The distal end of the urethra is split longitudinally for a distance of a quarter of an inch and each half is sutured to the margin of the opening in the ventral flap.

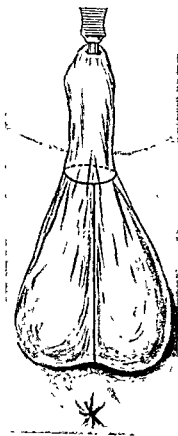
The wound is painted with disinfectant, and a circular dressing applied to the stump of the penis.

After-Treatment. Stitches are removed on the eighth day and contraction of the new urethral opening is prevented by the regular passage of bougies. Excoriation of the scrotal skin is prevented by the daily application of vaseline.

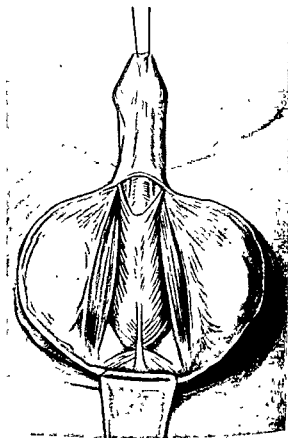
Complete Amputation. The preparation of the patient and the anæsthetic are the same as for partial amputation.

Operation. The patient is placed in the lithotomy position, the external genitals are painted with 3 per cent picric acid in spirit and isolated by sterile mackintoshes and towels.

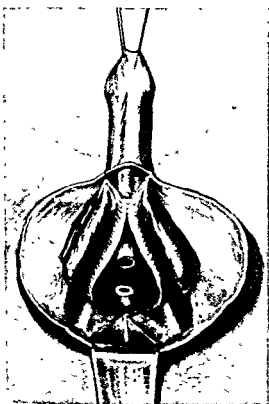
A steel sound is passed into the bladder and a circular incision made around the base of the penis and continued vertically downwards in the middle line of the scrotum to the perineum, ending about one inch away from the anus (fig. A, 1740A).



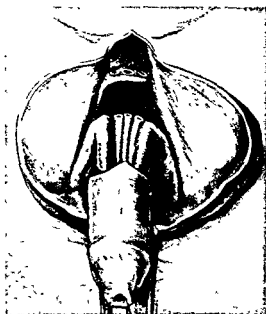
A. LINE OF INCISION



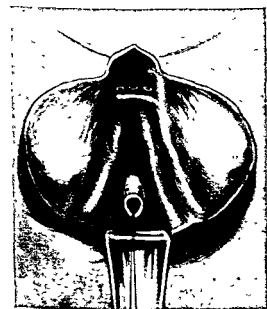
B. EXPOSURE OF BULBO CAVERNOUS AND ISCHIO-CAVERNOUS MUSCLES, AFTER SLITTING THE SCROTUM.



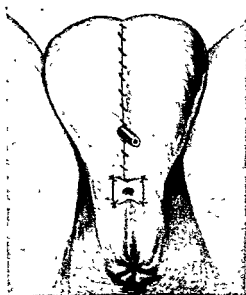
C. DIVISION OF URETHRA AFTER SECTION OF BULBOCAVERNOUS MUSCLE. FREING OF CRURA.



D. DORSAL VESSELS LIGATURED; SEPARATION OF CRURA COMPLETED.



E. PENIS AND CRURA REMOVED.



F. OPERATION COMPLETED; URETHRA SPLIT AND SEWN TO WOUND EDGES.

The dorsal vessels of the penis are seized with artery forceps close to the pubic arch, divided and ligatured, and the suspensory ligament of the penis is cut across. The vertical incision from the scrotum is deepened accurately in the middle line, whereby the scrotum is split into two halves which are retracted laterally (fig. B, 1740A). The vertical incision is still further deepened until the urethra is exposed. The steel sound is removed from the bladder and the urethra cut through about $1\frac{1}{2}$ inches distal to the triangular ligament (fig. C, 1740B).

The whole penis is next drawn downwards and the crura of the corpora cavernosa freed from the sides of the pubic arch by means of a raspatory, care being taken not to injure the proximal cut end of the urethra (fig. D, 1740B). The latter is next split for a distance of $\frac{1}{4}$ inch vertically and each flap stitched to the sides of the skin wound.

A drainage-tube is placed between the pubic rami, and the skin edges united around it by a continuous suture of No. 1 catgut (figs. E and F, 1740B).

The wound is painted with disinfectant and dressings are applied.

After-Treatment. The tube is removed on the third day and the stitches on the eighth day, and contraction of the new urethral orifice is prevented by intermittent dilatation with bougies.

DISEASES OF THE SCROTUM

NEW GROWTHS

Innocent. These are rare and resemble those in other parts of the body. Sebaceous cysts are the commonest variety and are usually multiple.

Treatment. Excision.

Malignant. The great majority of these are squamous-celled carcinomata (epitheliomata), although melanotic sarcomata have been known to arise in this situation.

Carcinoma, also called chimney-sweep's cancer, occurs most frequently in men engaged in such occupations as chimney-sweeping and tar-working. It begins as a warty outgrowth which is much softer than the corresponding penile cancer, and for a time behaves as an innocent tumour. Later, ulceration takes place with formation of the typical epitheliomatous ulcer.

The inguinal glands enlarge, at first by inflammation but later by growth, and become hard and matted. Metastases in other organs are rare. Secondary nodules of growth may occur in other parts of the scrotum from lymphatic spread.

Treatment. Workers in substances which predispose to cancer should be warned to exercise great cleanliness and to present themselves for examination if they develop any warts or other apparently innocent growths; these must be removed without delay. If a carcinoma is present, it should be excised with a large area of surrounding healthy skin and the inguinal glands be treated by the application of radium plaques (see page 1614) on both sides or removed by block dissection.

IMPERFECT MIGRATION OF THE TESTIS

The testis normally reaches the internal inguinal ring by the sixth month of intra-uterine life, the external by the eighth month, and the scrotum at birth or shortly afterwards. It may be *arrested* in any part of its normal course between the lumbar region and the scrotum, the positions being classified as lumbar, iliac, inguinal, or inguino-scrotal. It may fail to follow its normal course and pass into an abnormal or *ectopic* position—ectopia being perineal, femoral, superficial inguinal, cruro-scrotal, or pre-penile. In both arrest and ectopia of the testis the organ is frequently imperfectly developed, and in one-eighth of the cases the condition is bilateral. The following pathological conditions may be associated: injury, inflammation, hernia, hydrocele, torsion of the spermatic cord, and malignant disease.

Injury. This is more common in the inguinal and perineal testes, owing to their exposed position.

Inflammation. This is similar to that which may attack a normally placed organ.

Hernia and Hydrocele. It is stated that in 80 per cent of imperfectly migrated testes a patent processus vaginalis is present, passing into the scrotum even when abdominal arrest or ectopia has occurred, thus providing a potential hernial sac into which abdominal contents may descend, or a congenital hydrocele form.

Torsion of the Spermatic Cord. This may follow some violent muscular effort and give rise to symptoms simulating strangulated hernia.

Malignant Disease. This is said to be relatively more common in an imperfectly migrated testis, but the statement is questionable.

Symptoms and Signs. Arrest and ectopia may be symptomless, but as a rule there are attacks of pain coming on spontaneously or following exercise. The pain may be due to pressure on the testis or to minor degrees of torsion of the cord.

Diagnosis. This is made by finding the scrotum empty on one side and, in most cases, by feeling the testis in an abnormal position. It must be remembered, however, that in young children the cremaster muscle can easily withdraw the testis from the scrotum into the inguinal canal, especially if the examining fingers are cold.

Treatment. This should be operative in all cases of imperfect migration other than abdominal which are diagnosed over the age of five years, and operation should be carried out as soon afterwards as possible. In only the very rarest circumstances does further migration occur after this age, and testes left in an abnormal position will undergo fibrotic and other degenerative changes and be liable to the complications which have already been mentioned.

One of two procedures may be adopted: (1) Orchidopexy, or (2) Orchiectomy (see page 3042).

In all bilateral cases orchidopexy should be attempted because this operation is the only means of inducing the power of spermatogenesis which will most certainly fail to develop if nothing is done, although the internal secretion is normal and secondary male characteristics appear. The side on which the testis is more perfectly migrated is operated upon first, the other side being left for at least three months.

Orchidopexy (Ombredonne's method). An incision $2\frac{1}{2}$ inches long is made from a point just lateral to the spine of the pubis on the affected side, extending upwards and outwards, parallel to and half an inch above Poupart's ligament.

The skin and subcutaneous tissues are divided until the external oblique aponeurosis is exposed; all bleeding points are seized with artery forceps and tied off with No. 0 plain catgut; towels are clipped

into position at the skin margins, and the external oblique aponeurosis is cleared of all overlying fatty tissue.

The external abdominal ring is identified with the finger, an incision is made in the line of the fibres of the external oblique, extending upwards and outwards from the ring for a length similar to the skin incision, and its upper and lower margins are stripped away from the underlying internal oblique. The cord, which will be seen lying above the testis in some part of the inguinal canal, is grasped, put on the stretch, and freed as far as possible from its surroundings by gentle gauze stroking, until a finger can be passed beneath it. It is next followed up to the internal abdominal ring and still further



A. DIVISION AND LIGATION OF HERNIAL SAC.



B. LIGATURE TIED ROUND GUBERNACULUM AND LEFT LONG. THE ARTERY FORCEPS AND THE SECOND LIGATURE ARE NOT SHOWN.

Fig. 1741A.—ORCHIDOPEXY OMBREDONNE'S METHOD. (After Rowlands and Turner)

freed, when, in most cases, a small white glistening hernial sac will be seen. After identifying the vas, this hernial sac is isolated by gauze dissection from the other structures of the cord and divided with a knife about one inch from the internal abdominal ring, the distal part being left attached to the cord and testicle (fig. A, 1741A). The isolation of the sac frequently constitutes a most difficult stage in the operation, and great care must be taken to prevent injury to the vas or its accompanying vessels. The proximal end of the sac is completely freed from the cord, is transfixed at its neck after inspection of its interior, and ligatured, the redundant portion being cut away. A portion of the gubernaculum is found to attach the testis either to the spine of the pubis or to the interior of the scrotum, and is picked

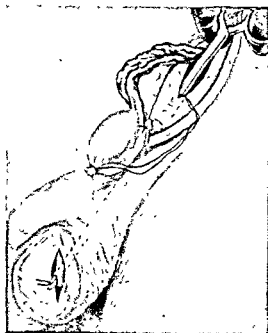
up with artery forceps in two places, divided between them, and the distal end ligatured with No. 2 plain catgut. The proximal end is transfixed, tied off, and the ends of the ligature left long, care being taken not to include the vas, which sometimes forms a loop below the testicle (fig. B, 1741A). In some cases the foregoing is all that is necessary to ensure an adequate length of cord for the testis to reach the scrotum. In others, the incisions through the skin and external oblique aponeurosis must be extended upwards to a point about $1\frac{1}{2}$ inches internal to the anterior superior spine of the ilium, and the underlying abdominal muscles divided down to the peritoneum in the line of the skin incision. The peritoneum covering the lateral aspect of the iliac fossa is then stripped inwards by gauze pressure, whereby the spermatic vessels are displaced towards the middle line for a slight distance. This procedure will be found to give an extra length of cord, which varies from one to two inches, and may be sufficient to allow the testis to reach the scrotum. In a few cases this additional step is inadequate and further lengthening of the cord will be required, which now can only be obtained at the expense of the blood supply with consequent risk of atrophy of the testicle.

The vas and its artery are left intact, but all other blood-vessels are divided between ligatures. If the lengthening of the cord obtained by this method is still insufficient, the testicle should be removed. If an adequate length of cord is obtained by one or other of the foregoing methods, the testicle is transplanted to the opposite side of the scrotum in the following manner: A vertical incision, one inch in length, is made through the anterior surface of the scrotum, half an inch lateral to the medium raphé, but on the side opposite to the testicle. The incision is deepened until the fibrous sheath of the tunica vaginalis is reached, care being taken not to injure it (fig. C, 1741B).

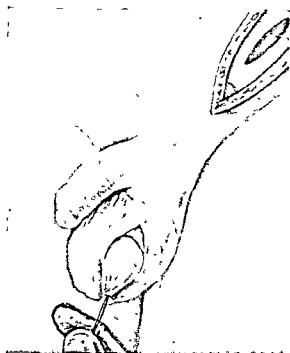
After picking up and ligaturing any bleeding vessels, a bed is prepared by blunt dissection between the tunica vaginalis and the inter-scrotal septum. A pair of long slender forceps is clipped on to the end of the ligature which was tied round the remains of the gubernaculum near the testis, and its point passed down into the scrotum from the inguinal wound, and made to press upon the inter-scrotal septum and invaginate it into the opening in the opposite side of the scrotum. With a knife a small incision is made over the point of the artery forceps, which will now present, carrying the ends of the ligature (fig. D, 1741B). These ends are secured by means of a second pair of artery forceps, the first pair being unclipped and removed from the inguinal wound. By opening up the blades as far as possible during their withdrawal, the soft parts will be stretched sufficiently to allow the



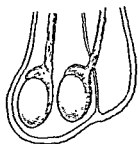
C. TESTIS AND CORD FREED.



D. INCISION MADE THROUGH OPPOSITE SIDE OF SCROTUM.



E. FINGER AND THUMB GRASPING LIGATURE PASSED FROM INGUINAL TO SCROTAL WOUND THROUGH INTER SCROTAL SEPTUM. TESTIS PULLED FROM INTER SCROTAL SEPTUM.



F. SCROTUM AFTER OPERATION. (DIAGRAMMATIC VIEW.)

testicle to be drawn down into the scrotum by pulling on the long ligature (fig. E, 1741B). The success of the operation depends on the size of the incision through the inter-scrotal septum, which is just sufficient to allow the testicle to be partly pulled and partly squeezed through it, when the opening will contract behind the testicle and prevent its return into the inguinal canal. The ends of the long ligature are cut short and no additional sutures are placed in the testis to secure it in position (fig. F, 1741B).

The scrotal wound is closed by a fine continuous catgut stitch and the external abdominal ring is reconstructed by inserting a No. 1 chromicized catgut suture through the external oblique aponeurosis and the innermost extremity of Poupart's ligament, care being taken to ensure that the opening is sufficiently large to prevent strangulation of the vessels of the cord. The upper cut margin of the external oblique aponeurosis, together with the underlying conjoint tendon, is stitched down to the under-surface of Poupart's ligament superficial to the cord by means of two or three interrupted sutures of No. 1 chromicized catgut. The lower half of the external oblique aponeurosis is made to overlap the suture line and is sewn down to the upper part of the external oblique.

For some time the tension of the cord may drag the scrotum upwards, but gradually the constant slight weight of the scrotum and the elasticity of the inter-scrotal septum will bring the testis down to a normal position. The skin stitches are removed on the eighth day, the continuous catgut scrotal stitch being allowed to separate naturally.

In bilateral cases a similar procedure is carried out some three months later, when the right testis will occupy the left side of the scrotum and the left testis the right.

TORSION OF THE SPERMATIC CORD

Torsion or twisting of the spermatic cord occurs in most cases about puberty, and is usually associated with some developmental error such as :

- (a) Imperfect migration of the testis, present in the majority of cases, its usual position being in the inguinal canal.
- (b) Abnormal mobility of the testis, due to persistence of its mesentery, within the tunica vaginalis.
- (c) Abnormal suspension of a testis, causing it to lie with its long axis horizontally.

The twist may be a half turn only, but as many as four complete turns have been described. The exciting cause is unknown, as cases have occurred both during violent exercise and during sleep. The condition is acute in the great majority of cases, but chronic torsion may occur.

Acute Torsion. Symptoms and Signs. The clinical features are those of an acute epididymitis, the condition closely resembling an acute strangulated hernia. A sudden violent pain is felt in the testicle, inguinal canal, and lower part of the abdomen, accompanied by vomiting and severe shock. As the latter subsides there may be some rise of temperature and pulse-rate. Near the external abdominal ring there is an exquisitely tender swelling which is irreducible and has no impulse on coughing. The overlying skin is red and cedematous, the corresponding half of the scrotum is empty, and there may be a little fluid in the tunica vaginalis. On examination the rectum and the urine are found to be normal.

Diagnosis. The condition is distinguished from acute epididymitis by the absence of a primary infection of the urethra, prostate, or vesicles and the extremely sudden onset of testicular pain.

Acute torsion may be distinguished from strangulated hernia (for which it is usually mistaken) by the fact that the scrotum is empty and that constipation and inability to pass flatus are not absolute.

Treatment. Immediate operation. A free incision is made over the swelling, and the testis and cord are exposed. In all cases of imperfect migration, orchidectomy should be performed, the processus vaginalis separated and ligatured, and the internal abdominal ring closed.

In the few cases in which the testicle is in the scrotum, and is presumably well developed and of normal function, an attempt may be made to untwist the cord and to anchor the testis in the lower part of the scrotum, with drainage of the tunica vaginalis for 24 hours. If, however, there is any difficulty in untwisting the cord, or if there is any enlargement of the testis from extravasated blood or signs of thrombosis of the vessels of the cord, orchidectomy should be carried out.

Even after the conservative operation, atrophy of the testicle is the rule, and in many cases great pain and tenderness persist, necessitating removal of the organ at a later date.

Chronic Torsion. This term is applied to a few rare cases in which there are recurrent attacks of pain from repeated twists of the cord,

which are reduced spontaneously or by manipulation. Atrophy of the organ does not necessarily follow the first attack, but may do so after subsequent twists.

Treatment. Orchidectomy, if imperfect migration is present. If the testis is fully descended it should be exposed and sutured to the scrotum.

ORCHIDECTOMY

Indications. (1) Some cases of imperfect migration of the testis in which orchidopexy is impossible; (2) new growths of the testis; (3) some cases of torsion of the spermatic cord; (4) some cases of injury; (5) some cases of tuberculous, bacillus coli or pyogenic epididymitis.

Pre-operative Preparation. This consists of a perineal shave and the painting of the external genitals with 3 per cent picric acid in spirit the day before the operation.

Anæsthesia. A general anæsthetic is essential, and gas and oxygen preceded by intra-rectal avertin or intravenous evipan is advised.

Operation. The patient is placed in the dorsal position and the external genitals are painted with 3 per cent picric acid in spirit. Mackintoshes and towels are clipped in position, leaving the scrotum and the inguinal region on the affected side exposed.

An incision, two inches in length, is made over the external inguinal ring and deepened until the spermatic cord is exposed.

In all cases, other than malignant diseases of the testis, the cord is freed from its surroundings by blunt dissection, a finger being passed underneath the cord, which is transfixed with a blunt aneurysm needle threaded with No. 2 chromicized catgut and tied off in two separate bundles. A pair of Spencer Wells forceps is applied $\frac{3}{4}$ inch distal to the ligature, and the cord is cut away on its proximal side. The testis is dislocated from the scrotum through the wound and freed from its surroundings as far as possible. As a rule it will be found to be attached to the lower part of the scrotum by the remains of the gubernaculum. The latter is clamped with forceps, the testis cut away, and the ligature tied as the forceps are removed.

A stab wound is made in the most dependent part of the scrotum, and a small rubber drainage-tube inserted and fixed by a single fishing-gut stitch. Any bleeding point is picked up and ligatured and the wound closed in the usual way.

For malignant disease of the testis, see page 3051.

INJURIES OF THE TESTIS

The commonest result of injury to the testis is traumatic orchitis, the usual cause being a blow or a squeeze producing extravasation of blood into the tunica vaginalis (traumatic hæmatocele), into the testis itself, or, very rarely, into the epididymis. The testis may also be accidentally punctured or incised.

Symptoms and Signs. These may be severe and include vomiting and collapse. The testis is painful, especially when hæmorrhage is occurring within the tunica albuginea and there is swelling and ecchymosis of the scrotum, which in severe cases may extend up the spermatic cord to the internal abdominal ring. The orchitis may persist for some days, tenderness continuing after the initial shock and pain have subsided.

Treatment. This consists of rest, elevation of the scrotum on a broad piece of strapping stretched across the thighs, and the application of an ice-bag or cooling lotions. Later, support should be provided by a suspensory bandage.

Should a hæmatocele occur, it is treated as described on page 3061.

Results. With mild injuries there is usually complete recovery, but severe cases are commonly followed by some degree of atrophy.

INFLAMMATORY DISEASES OF THE TESTICLE

The testicle is composed of two parts : the body and the epididymis. Inflammation may primarily affect the body (orchitis) or the epididymis (epididymitis), but in either case, after a certain period, the rest of the organ becomes secondarily involved with resulting epididymo-orchitis. As a rule only one testicle is affected, although in some cases inflammation may attack the second while subsiding in the first.

EPIDIDYMITIS

Epididymitis is secondary to inflammation of the prostate and vesicles, the infecting organisms reaching the epididymis by direct extension along the lymphatics surrounding the vas.

Three main varieties should be distinguished: (a) Gonococcal; (b) Non-gonococcal; and (c) Tuberculous.

(a) *Gonococcal Epididymitis* may occur during the second or third week of a gonococcal posterior urethritis. Infection spreads from the posterior urethra to the prostate and vesicles, and from there to the epididymis via the lymphatics surrounding the vas. Gonococcal epididymitis is acute in its onset and often coincides with a diminution or cessation of urethral discharge.

Symptoms and Signs. The attack usually begins with pain in the groin and lower abdomen and is soon followed by increased pain and swelling of the testicle. There is some fever, and the patient looks and feels ill.

The scrotum is red and oedematous, and may be adherent to the epididymis behind and below. A certain amount of secondary hydrocele is almost invariably present.

The epididymis, especially the globus minor, is much swollen and exquisitely tender. Owing to the pain, the testicle can rarely be palpated, but is normal in size. The cord is swollen, hard and tender, and it is usually impossible to distinguish the vas.

Rectal examination reveals a swollen tender prostate and vesicle. The external urinary meatus is usually inflamed, and as a rule a little discharge can be obtained by "milking" the urethra.

The attack reaches its height about the fifth day, and gradually subsides in about ten days, when only a little thickening of the globus minor remains which is tender on palpation. This thickening may result in fibrosis and obstruction of the tubules of the epididymis, leading to sterility of the affected organ.

Suppuration only occurs in mixed infections (see Non-gonococcal Epididymitis). The fluid in the tunica vaginalis is, as a rule, absorbed, but in some cases a hydrocele may persist.

Diagnosis. The condition is distinguished from non-gonococcal epididymitis by the history, the bacteriological examination of the discharge, and other signs of gonorrhœa.

Treatment. Absolute rest in bed is essential, and all local treatment of the urethra and prostate must be discontinued. The scrotum is covered with an ice-bag and elevated on a broad piece of strapping stretched across the thighs (fig. 1742). The bowels should be kept well

open, and empirin compound, morphia, or suppositories of morphia and belladonna be given for the relief of pain. Alkalis and large quantities of fluids, such as Contrexéville, Vittel, and barley-water are given by mouth. 1 cc. of S.U.P. 36 is injected intramuscularly, and is followed by another in 24 hours. In very acute cases puncture of the epididymis with a fine hypodermic needle will afford great relief.

As the inflammation begins to subside, the patient is allowed up with the testis well supported in a suspensory bandage. Of great value at this stage is the application of heat, to promote the absorption of inflammatory products, either in the form of hot fomentations or best

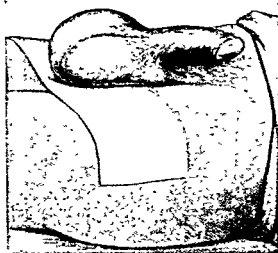


Fig. 1742.—ACUTE EPIDIDYMITIS. ELEVATION OF THE SCROTUM ON BROAD PIECE OF STRAPPING BETWEEN THE THIGHS.

of all by diathermy, the testicles resting in a bath of salt solution to which is attached one cable of the machine, the other being connected with a lead plate let into the seat on which the patient sits (fig. 1743).

When all acute symptoms have disappeared, local treatment of the urethra, prostate and vesicles is gently recommenced until the disease is cured.

(b) *Non-Gonococcal Epididymitis.* The most frequent organisms which produce this variety of epididymitis are coliform bacilli, staphylococci, and streptococci. They reach the epididymis from the prostate and vesicles via the lymphatics which surround the vas. Predisposing causes include prostatitis, vesiculitis, vesical calculus, and enlarged prostate or stricture, especially where residual urine is present. Sometimes prostatic massage or the passage of instruments, such as catheters

or sounds, or operations on the prostate or urethra will determine an attack of epididymitis, but often no such exciting cause is present.

Both chronic and acute epididymitis can occur.

Chronic Non-Gonococcal Epididymitis. This may follow an acute attack or be chronic from the beginning. It is usually noticed during the routine examination of male patients, when some degree

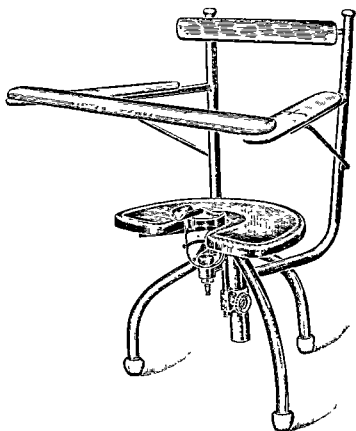


Fig. 1743.—AUTHOR'S CHAIR FOR TESTICULAR DIATHERMY.

of adhesion is felt between the epididymis and testis, or some thickening or a nodule in the region of the globus minor. These signs always indicate chronic genital infection, and other evidences will be found in the prostate, vesicles, and often in the posterior urethra and bladder, e.g. the urine after prostatic massage may contain pus and organisms.

Treatment. The discovery of chronic epididymitis always demands a thorough examination of the lower urinary and genital tracts. Any focus of infection which is found must be treated, e.g. prostatic massage and dilatation of the bladder neck for chronic prostatitis.

Acute Non-Gonococcal Epididymitis. Symptoms and Signs. These are similar to the gonococcal variety which is excluded by the history, the bacteriological examination of the urethral discharge, and other signs of gonorrhœa.

The majority of cases end in resolution or fibrosis, but in a certain number pus formation takes place.

Treatment. This resembles that for gonococcal epididymitis. If, however, suppuration occurs, the pus must be evacuated by immediate incision. The commonest site is in the tunica vaginalis, the fluid in all cases being more or less purulent. A fluctuating swelling forms in front of the testicle, and redness and œdema of the surrounding skin are marked characteristics. Care must be taken not to carry the incision through the tunica albuginea, thereby infecting the testis. Suppuration may also occur in the body of the testis, resulting in gangrene and atrophy which will require orchidectomy.

An abscess in the lower and back part of the scrotum indicates a suppurative epididymitis and must be incised. It is invariably followed by sterility of the testicle on the affected side.

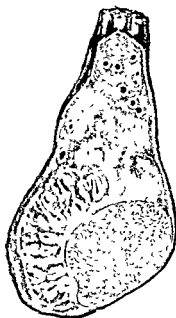


Fig. 1744.—TUBERCULOUS EPIDIDYMITIS.
(Operation specimen, St. Paul's Hospital Museum.)

(c) *Tuberculous Epididymitis* (fig. 1744). This is secondary to tuberculosis of the seminal vesicles and prostate, organisms passing to the epididymis along the lymphatics surrounding the vas. It is doubtful whether a blood-borne infection ever occurs. The disease is commonest in young adults between the ages of 20 and 30 years.

Both chronic and acute forms may occur, but the latter is rare.

Chronic Tuberculous Epididymitis. Symptoms and Signs. The onset is insidious, the first symptom usually being a little aching in the affected testicle, but often a small nodule is noticed accidentally by the patient or during a routine examination. The nodule is very hard, not tender, and is situated in either the globus minor or major. The vas is thickened, sometimes beaded, and can be isolated from the other

constituents of the cord which are normal. After a time the nodule may shrink, but more often it increases in size and other nodules appear which, after some months, soften into a fluctuating swelling.

The skin on the lower and posterior aspect of the testicle becomes adherent and reddened, and the swelling eventually bursts at this point, discharging pus and leaving a sinus which rarely heals, and generally becomes secondarily infected. Occasionally a mass of tuberculous granulation tissue is extruded (*fungus testis*). When this occurs the cord becomes matted and the vas can no longer be palpated separately.

Clinically the body of the testis is normal, but, after removal, examination will show that it has suffered a secondary invasion. In one-third of the cases there is some degree of hydrocele.

Rectal examination will reveal thickening of the vesicle on the same side and sometimes on the opposite side, and nodules can often be felt in the prostate.

Secondary cystitis may occur with resulting frequency and terminal dysuria. The urine is acid, contains pus, and the tubercle bacillus can sometimes be found. If untreated, the disease tends to become bilateral by extension from the vesicles down the vas to the testicle on the opposite side.

Treatment. This should, in the majority of cases, be conservative, constitutional measures being adopted as for the treatment of tuberculosis of other parts of the body. Beyond supporting the scrotum in a suspensory bandage no local treatment should be advised. Alkalis should be given by mouth. Injections of tuberculin T.R. are of great value. The initial dose is $\frac{1}{10}$ cc. of a dilution of 1 in 100, which corresponds to 0.001 of the undiluted T.R. Injections are given twice weekly, and the dose is gradually increased until finally 1 cc. of T.R. is reached. A general reaction should be avoided as far as possible; should it occur, the same dose is given a week later.

It may take three months or more to complete the course.

Urinary complications, if present, must be dealt with as described under "Tuberculosis of the Kidney."

Surgical treatment is unsatisfactory as the epididymitis is merely an extension of the tuberculous disease of the prostate and vesicles, and for this reason vaso-ligature on the sound side is of great value to prevent involvement of the other epididymis. Orchidectomy should be reserved for cases of fungus testis, or when persistent suppuration with sinus formation has occurred.

Acute Tuberculous Epididymitis. Symptoms and Signs. The onset is sudden with severe pain, general smooth enlargement of the epididymis and reddening of the scrotum. A secondary hydrocele soon forms with increasing pain and swelling. The epididymis is extremely tender and there is thickening of the vas. The disease closely resembles gonococcal epididymitis, but unlike it there is no urethral discharge and the swelling does not subside in a week or ten days, although the pain and tenderness may diminish considerably. In most cases suppuration of the epididymis occurs and an abscess forms within two or three weeks, involving the body of the testis.

Treatment. Orchidectomy as soon as the diagnosis has been made.

ORCHITIS

Orchitis may be due to trauma, or be caused by infection of the body of the testis from the blood stream during the course of general infections such as syphilis or mumps. In very rare cases, orchitis has occurred in typhoid fever, smallpox, scarlet fever, influenza, and malaria.

(a) *Syphilitic Orchitis.* In the majority of cases this occurs during the tertiary stage of the disease, and is characterised by diffuse fibrosis or localised gummata, the two being commonly associated.

Symptoms and Signs. The onset is insidious, the first sign noticed being a slow painless enlargement of the testicle, accompanied at times by a feeling of weight in the scrotum and aching in the cord. The enlargement is confined to the body of the testis and is unilateral in most cases. It may be nodular or smooth and feels extremely hard. Tenderness is absent and testicular sensation is lost. In almost all cases a secondary hydrocele is present, and may have to be tapped before a diagnosis can be made. The vas and other constituents of the cord are not affected. Rectal examination reveals a normal prostate and vesicles. The urine is free from pus and organisms.

In the later stages areas of softening may be felt in the testicle, the skin of the anterior aspect of the scrotum becoming reddened and adherent and breaking down, with formation of a typical gummatous ulcer with its wash-leather slough and discharge of gummy material. Fungus testis may occur due to extrusion of the testis through the ulcer.

Diagnosis. Syphilitic orchitis is distinguished from new growth by its longer history, rapid response to anti-syphilitic measures, the presence of other signs and a history of syphilis. The Wassermann reaction is positive.

From tuberculous epididymitis the diagnosis is established by the involvement of the body of the testis, the absence of pain or tenderness, the early loss of testicular sensation, and the freedom of the prostate and vesicles from disease.

Treatment. The results of anti-syphilitic treatment, combined with the administration of large doses of potassium iodide, are extremely good. Orchidectomy should be reserved for resistant cases with ulceration or fungus testis. The scrotum should be supported in a suspensory bandage, and if the secondary hydrocele contains more than a few drachms of fluid it should be tapped.

(b) *Orchitis of Mumps.* This variety usually develops between the sixth and eighth day of the parotitis. It is rare before the age of eight or after twenty-five.

Signs and Symptoms. The body of the testis rapidly becomes hard, painful, and exquisitely tender and a secondary hydrocele usually forms. As a rule the condition is unilateral, but it may be bilateral.

The orchitis rarely lasts more than four days, but atrophy sometimes follows, leading to sterility on the affected side and persistence of a small flaccid hydrocele. In bilateral cases complete sterility may occur, with impotence and sometimes infantilism.

Treatment. Rest in bed, warmth, and support of the scrotum until all swelling has disappeared.

ATROPHY OF THE TESTICLE

This is due to two main causes—inflammation of the testis or epididymis ending in fibrosis, or degeneration of the glandular tissue without fibrosis.

(a) *Inflammatory Atrophy.* This may follow any of the varieties of epididymitis or orchitis, but most commonly injury, mumps, tuberculosis or syphilis. The atrophy is usually partial, but may be complete; it may also be unilateral or bilateral. The testis becomes smaller and

harder than normal, and is frequently nodular. A secondary hydrocele is often present.

(b) *Degenerative atrophy.* This may follow accidental or operative

injury to the vessels of the cord, pressure from old-standing herniae, hydroceles, or varicoceles; or may be associated with severe constitutional diseases, such as diabetes or leukaemia. The testis and epididymis become soft and flabby, and are affected on one or both sides.

In either the inflammatory or the degenerative type, unilateral atrophy is of no great importance, but, if bilateral, it will lead to some degree of sterility which in advanced cases may become complete.

Treatment. This must be directed to the cause of the atrophy.

NEW GROWTHS OF THE TESTICLE

Innocent new growths are so rare that for practical purposes it may be assumed that all neoplasms of the testicle are malignant; thus early diagnosis and operation are matters of supreme importance. The variety of growth is of secondary interest, for although there is much variation in their degree of malignancy, the clinical picture is more or less the same whatever type of neoplasm is found. All invade the body of the testis primarily. On microscopic examination after removal two varieties—the teratoma and the seminoma—can be differentiated, both being equally common.

Teratoma. In this growth all three germinal layers are represented, although one usually predominates and achieves malignancy, giving rise in the case of epiblast to the teratogenous chorion-epithelioma; in the case of mesoblast, to the teratogenous sarcoma; and in the case of hypoblast, to the teratogenous carcinoma.

Of these, the great majority are of the carcinomatous type, chorion-epitheliomatous and sarcomatous being rare. They commonly occur between puberty and 30 years.

Testicular dermoids constitute the rarest variety of teratomata, and appear as cysts lined by squamous epithelium and occupied by sebaceous matter and hair. Occasionally more highly differentiated structures, such as nerve tissue, are found in their walls. Dermoids, as a rule, appear in the first year of life and are innocent tumours.

Seminoma. This is a carcinoma arising from the seminiferous epithelium. It differs from the teratogenous carcinoma in that it commonly occurs in patients between the ages of 30 and 50, has a longer history, and is much slower in giving rise to metastases.

Symptoms and Signs. In the early stages there is a complete absence of pain or tenderness, the first symptom being a feeling of weight in the scrotum. Later, especially when there are secondary deposits in the lymphatic glands, pain may become severe; at first localised to the testis and cord, it is subsequently felt in the lumbar region and abdomen.

On examination, the body of the testis is found to be uniformly enlarged, hard, and extremely heavy. At first the surface is smooth, but later it becomes irregular and, in places, areas of softening occur due to degenerative changes and hæmorrhage. Testicular sensation is lost early. A secondary hydrocele, or more rarely a hæmatocele, is frequently present.

Hypertrophy of the cremaster muscle occurs from the increased weight of the organ, making the cord feel thickened, while enlargement of the veins is often present. Rectal examination is normal. The urine is a most important aid to diagnosis as it will contain prolan A, the amount of which can be estimated by appropriate biochemical methods. It is free from other abnormal constituents. In later cases, palpable masses, which do not move on respiration, may be present in the abdomen, usually in the lumbar regions. Occasionally dilatation of the superficial veins of the abdomen may occur from pressure on the vena cava, and later ascites and œdema of the lower extremities.

The patient shows the usual signs of cachexia and wasting, and generally dies before fungation of the primary growth takes place through the scrotum.

Diagnosis. This must be made from hydrocele, hæmatocele, and syphilitic or tuberculous disease (see also page 2688).

In hydroceles and hæmatoceles the history is usually sufficient to make a diagnosis, especially if they have been previously tapped, but some old standing hydroceles with thickened walls may present difficulty.

Chronic tuberculous epididymitis with secondary involvement of the testicle can, as a rule, be distinguished by the pain, the marked breaking down with adhesion to the skin at the back of the scrotum with sinus formation, the long history, and evidence of the disease in the prostate and vesicles. In syphilitic orchitis the body of the testis

is not much enlarged and is nodular. There is a history of syphilis, and the Wassermann reaction is positive.

Treatment. Orchidectomy with removal of the cord as far as the internal ring and treatment of the whole of the lymphatic areas by deep X-rays, whether secondary deposits are present or not, and at least four applications of the radium bomb to the groin on the affected side (see page 1614). Special points in the operation consist of the avoidance, if possible, of pre-operative tapping, the employment of great clinical and operative gentleness, the reduction of manipulation to a minimum, ligation and cutting of the cord at the internal ring after incising the aponeurosis of the internal oblique and before dealing with the testicle, and the avoidance of any incision into the growth until after its removal.

Some surgeons still advocate the radical operation of orchidectomy, which carries with it a high mortality. The results, however, have not shown any improvement over simple orchidectomy, when followed by radium and X-ray treatment, and will therefore not be described. If the urine after operation is free from prolan A, the prognosis is good.

CYSTS OF THE EPIDIDYMIS

Cysts of the epididymis are of two kinds: (1) Large solitary cyst (spermatocele); (2) Small multiple cysts.

Occasionally both types are found in the same patient.

The *large solitary cyst*, or *spermatocele*, occurs in men under forty years of age, and contains a milky white opalescent fluid in which there is albumen and many spermatozoa in various stages of disintegration. It is thought to be caused by some block in the excretory system of a testicle still in the state of activity, with resulting formation of a retention cyst.

The *small multiple cysts* occur in middle-aged and elderly men, and contain a pale limpid fluid with only a trace of albumen. They are thought to be due to involutionary changes.

Symptoms and Signs. A spermatocele rarely attains any great size and does not trouble the patient, apart from the presence of a lump which he often assumes to be a third testicle. It forms a painless, globular, elastic and translucent swelling lying upon the upper pole of the testis, from which it can be almost completely isolated; this distinguishes it from a vaginal hydrocele. It extends upwards into

the cord, and, by depressing the body of the testis, causes the latter to lie more horizontally than normal. Tapping produces the characteristic milky opalescent fluid which confirms the diagnosis.

The multiple cysts are felt as small tense bodies, more numerous in the globus major than the globus minor, some of which may become pedunculated. They cause no symptoms and are of no importance clinically.

Treatment. Spermatoceles should be tapped with a fine trocar and cannula, and the treatment repeated if they refill. In younger subjects this is common and excision is to be preferred.

Injection treatment, see page 3278.

The small multiple cysts require no surgical interference.

HYDROCELE

A hydrocele is formed by an abnormal collection of fluid in the tunica vaginalis, or in some other part of the processus vaginalis which has not become obliterated.

The upper part of the processus vaginalis, as shown above the dotted line in figure 1745, should be obliterated soon after birth. The lower part forms the normal tunica vaginalis, and distension of this vaginal sac which is known as "vaginal hydrocele" is by far the most common (figs. 1746 and 1747).

Should obliteration of the processus vaginalis not occur or be incomplete, four other varieties of hydrocele may result, as shown in figs. 1748 to 1751.

(1) *Vaginal Hydrocele* (figs. 1746 and 1747) may be either acute or chronic.

(a) *Acute.* This may occur as a complication of an acute epididymo-orchitis, and be due to inflammation of the tunica vaginalis, or may occasionally be the result of trauma. It has been known to arise in the course of general diseases, such as septicæmia. Acute hydroceles usually resolve when treatment is directed to their cause. Suppuration sometimes occurs and will necessitate draining the tunica vaginalis.

(b) *Chronic.* This may be primary or secondary.

The secondary type is usually a complication of the chronic epididymo-orchitis of tuberculosis, syphilis, or malignant disease. The

treatment is directed to the primary condition, though many hydroceles, especially those of syphilitic origin, may require tapping before a diagnosis can be made.

The *primary or idiopathic type* is that in which no direct cause can be found for its origin, although some consider that it is the result of chronic genital infection, whereby the rate of production of the hydrocele fluid is in excess of its absorption. The fluid is straw-coloured, having a specific gravity of about 1025. It does not clot

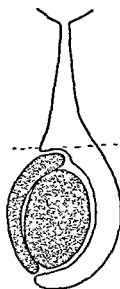


Fig. 1745.
UNORLITERATED PRO-
CESSUS VAGINALIS.



Fig. 1746.
VAGINAL HYDROCELE.

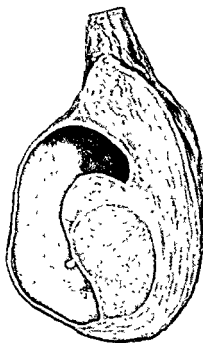


Fig. 1747.
VAGINAL HYDROCELE.
(Operation specimen, St. Paul's
Hospital Museum.)

on standing, but contains enough albumen to become almost solid on boiling. In old-standing cases thickening of the tunica vaginalis gradually occurs, with the production of some degree of atrophy of the testis.

Symptoms and Signs. A chronic vaginal hydrocele forms a painless pyriform swelling on one or other side of the scrotum, and gradually increases in size. It is smooth and elastic to the touch, and is translucent unless of many years' standing and thickening of the tunica has occurred. It is distinguished from hernia by the fact that the fingers can grasp the cord above it, and there is no impulse on coughing. There is dullness on percussion.

In the smaller varieties of primary hydrocele the testicle can be felt lying below and behind the swelling, but in the larger types it may be impalpable, when no diagnosis should be made until the fluid has been removed by tapping and the testis and epididymis have been carefully examined to exclude a primary cause, such as tuberculosis, syphilis, or new growth.

Treatment. This may be palliative by tapping, or curative by injection or operation.

(1) *Tapping.* This must be regarded purely as a palliative or diagnostic measure. Recurrence is the rule and the younger the patient the more quickly does the hydrocele refill.

Technique. A small well-fitting cannula and sharp trocar are selected and sterilised by immersion in spirit. The position of the testis is determined by palpation or trans-illumination, and an area of skin remote from this, usually on the lower part of the front of the scrotum, is painted with iodine or other suitable medicament.

The hydrocele is rendered prominent and the skin made tense by pressure of the fingers of the left hand, an area being selected which is free of blood-vessels, and the trocar and cannula sharply thrust through it in an upward and backward direction. The trocar is withdrawn and the fluid allowed to drain into a dish, pressure being made on the hydrocele with the fingers. When the fluid ceases to flow, the position of the cannula is slightly altered and the scrotum again squeezed. When no further fluid can be expressed, the cannula is withdrawn, the small wound painted with iodine and a collodion dressing applied.

(2) *Injection.* (See page 3275.)

(3) *Operation, or radical cure.* Under general anæsthesia an incision is made through the skin of the inguino-scrotal region over the upper part of the hydrocele and gradually deepened until its bluish shining sac is exposed. All bleeding points are carefully ligatured and the whole swelling is dislocated out of the scrotum, separation being effected by gentle pressure of the fingers.

The sac is opened, cut away with a knife or cautery close to its reflection on to the epididymis and removed. All bleeding points, however small, are underpinned and tied off, and a small tube is introduced through a stab wound at the bottom of the scrotum.

The testis is replaced and the incision closed with interrupted fishing-gut sutures.

After-Treatment. Pressure on the scrotum is maintained by a T-bandage applied over cotton wool, and the drainage-tube is removed 48 hours later.

Complete Congenital Hydrocele (fig. 1748). This type is due to persistence of the whole of the processus vaginalis. It may appear in infancy or only be noticed in adult life. The fluid either comes from the peritoneal cavity or is exuded from the vaginal sac, and though the size of the communication with the abdominal cavity varies, it is usually large enough to allow of reduction by pressure.

Symptoms and Signs. These resemble those of a hernia, but the hydrocele can be distinguished by its dullness to percussion, translucency, slow reduction without the characteristic gurgle, and its reappearance on standing, even when pressure is made over the internal abdominal ring.

Treatment. The majority of cases tend to cure themselves by gradual obliteration of the funicular process. This may be accelerated by wearing a truss. If the hydrocele still persists, excision is indicated, but never injection, owing to the communication of the sac with the abdominal cavity. At times a hernia is also present, and this should be dealt with by radical cure.

Infantile Hydrocele (fig. 1749). This resembles the congenital type, except that there is no communication with the peritoneal cavity, fusion of the neck of the processus vaginalis having occurred. The fluid is formed by the tunica vaginalis.

Symptoms and Signs. These resemble those of the congenital type, except that the hydrocele is irreducible. It appears soon after birth.

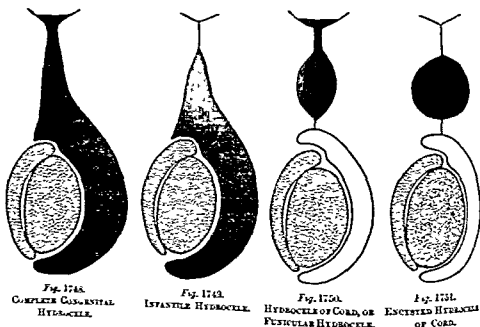
Treatment. Spontaneous cure is frequent and may be aided by tapping and the injection of sclerosing fluid. In other cases, on account of the tendency of the hydrocele to dilate the inguinal canal and predispose to hernia, excision should not be delayed too long.

Hydrocele of the Cord, or Funicular Hydrocele (fig. 1750). In this variety the tunica vaginalis is normal and is shut off from a patent funicular process above it.

Symptoms and Signs. An oval swelling, which is translucent and slowly reducible on pressure, surrounds the cord.

Treatment. Cure is usually spontaneous, but excision is necessary in some cases.

Encysted Hydrocele of the Cord (fig. 1751). This consists of a dilatation of that part of the processus vaginalis which lies between the abdominal cavity and the tunica vaginalis, but which has become shut off from them both.



Symptoms and Signs. A rounded or oval, freely mobile and translucent swelling is found lying anywhere in the cord between the testis and the external abdominal ring. The swelling moves with the testis and cannot be reduced on pressure.

The testis is replaced and the incision closed with interrupted fishing-gut sutures.

After-Treatment. Pressure on the scrotum is maintained by a T-bandage applied over cotton wool, and the drainage-tube is removed 48 hours later.

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Technique. A small well-fitting cannula and sharp trocar are selected and sterilised by immersion in spirit. The position of the testis is determined by palpation or trans-illumination, and an area of skin remote from this, usually on the lower part of the front of the scrotum, is painted with iodine or other suitable medicament.

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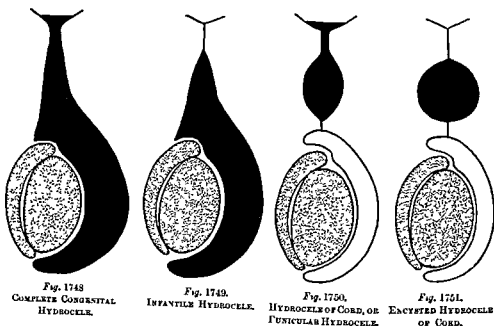
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Symptoms and Signs. An oval swelling, which is translucent and slowly reducible on pressure, surrounds the cord.

Treatment. Cure is usually spontaneous, but excision is necessary in some cases.

Encysted Hydrocele of the Cord (fig. 1751). This consists of a dilatation of that part of the processus vaginalis which lies between the abdominal cavity and the tunica vaginalis, but which has become shut off from them both.



Symptoms and Signs. A rounded or oval, freely mobile and translucent swelling is found lying anywhere in the cord between the testis and the external abdominal ring. The swelling moves with the testis and cannot be reduced on pressure.

Treatment. The cyst usually disappears spontaneously or on tapping and injection. If persistent, however, or if present in adults, it should be excised.

Other Varieties of Hydrocele. *Bilocular Hydrocele* (fig. 1752). This consists of two compartments, one of which runs downwards into the scrotum having the characteristics of an infantile hydrocele, while the other passes upwards between the skin and peritoneum, either behind or in front of the abdominal muscles.

Symptoms and Signs. The presence of an infantile hydrocele communicating with a cyst above Poupart's ligament.

Treatment. Excision of as much of the sac as possible, which may be exceedingly difficult and call for much surgical skill.

Chylous Hydrocele. This is similar to the common vaginal hydro-



Fig. 1752
BILOCULAR HYDROCELE.

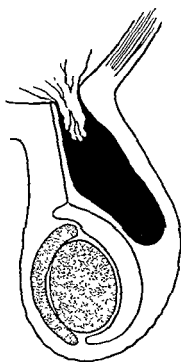


Fig. 1753.
HYDROCELE IN A HERNIAL SAC.

cele, except that the fluid resembles milk or chyle. It is due to lymphatic obstruction, most commonly by filariasis.

Treatment. That of the cause and excision of the hydrocele.

Hydrocele in a Hernial Sac (fig. 1753). This is due to exudation from the omentum or bowel into a hernial sac, the neck of which has become shut off by adhesions.

Symptoms and Signs. These resemble those of a congenital hydrocele. In addition, symptoms of an epiplocele or strangulated hernia may be present.

Treatment. This should be immediate and consist of radical cure of the hernial sac, as it is impossible to diagnose the nature of the obstruction of its neck, which may consist of a knuckle of gut.

HÆMATOCELE

A hæmatocele is a collection of blood in the tunica vaginalis, usually due to injury caused by tapping or too rapid emptying of any form of hydrocele. Occasionally the condition may occur spontaneously. Rarer causes include hæmorrhage following the radical cure of hernia, blows on the testicle, malignant growths of that structure and acute torsion of the cord. The condition may be acute or chronic.

Symptoms and Signs. Acute Hæmatocele. This is of rapid onset, usually following the tapping of a hydrocele or a blow on the scrotum. The scrotum swells rapidly, is tender and painful, of the shape of a hydrocele, and is semi-fluctuating but not translucent. The testis lies below and behind the swelling, but as a rule cannot be distinguished. The overlying skin is often red and œdematous and a rise of temperature may occur.

Tapping reduces the size of the swelling and blood can be withdrawn. If untreated, the pain may gradually diminish, the scrotal discoloration disappear, and the swelling become smaller. Occasionally suppuration occurs with formation of a pyocele. In most cases some thickening of the tunica vaginalis and blood clot remain, complete resolution being rare.

Chronic Hæmatocele. This is insidious in onset, and slow and often irregular in its enlargement, due to repeated small hæmorrhages. As a rule no cause for the condition can be elicited from the history.

The swelling is firm, irregular, and non-translucent, and it is impossible to distinguish the position of the testis. Testicular sensation is absent. Tapping results either in no escape of blood, or else in a few drops of dark brown fluid containing cholesterin and broken-down blood-corpuscles. The skin may be adherent over the swelling and be discoloured, and the cord thickened. The walls of the tunica vaginalis are much thicker than in hydrocele and are lined with laminated blood clot.

Suppuration may occur with formation of a pyocele.

Diagnosis. This is usually easy in acute cases. Chronic types are distinguished from hydrocele by their opacity and from hernia by the

fact that there is no communication with the abdomen and no impulse on coughing.

It is often very difficult and sometimes impossible to distinguish a hæmatocele from syphilitic orchitis, and especially from a new growth. The Wassermann reaction will exclude syphilis, but exploration is often necessary to exclude a neoplasm.

Treatment. In acute cases, rest in bed, scrotal support, tapping with a large-sized trocar, and the use of evaporating lotions should be tried. In chronic cases, especially if preceded by hydrocele or if there is any doubt about the diagnosis, operation should be advised.

Operation. This resembles that for hydrocele, the tunica vaginalis being excised and the scrotum drained; great care must be taken to arrest all bleeding. In late cases it may be necessary to remove the testis as well.

Hæmatocele of the Spermatic Cord. This may be localised and due to hæmorrhage into an encysted hydrocele of the cord, or diffuse from rupture of one of the veins in the pampiniform plexus following a blow or a severe straining effort.

Treatment. The localised type should be dissected out. In the diffuse variety the treatment should be expectant, but if the swelling is of large proportions it should be incised, the clot evacuated, and the bleeding point secured.

PYOCLE

This consists of a collection of pus in the tunica vaginalis. It may occur as a complication of hydrocele, hæmatocele, or suppurative epididymitis, or follow operations on the scrotum. It has been known to occur in pyæmia.

Treatment. Incision and drainage.

VARICOCELE

A varicocele is a varicose dilatation of the pampiniform plexus of veins surrounding the cord which arise from the upper pole of the testis and unite at the external abdominal ring to form three trunks, two anterior and one posterior to the cord. At the internal abdominal

ring these form a single spermatic vein which on the right side opens into the inferior vena cava, and on the left into the left renal vein.

There are two main types of varicocele. Primary and secondary. (a) The *primary* or congenital variety is probably due to a congenital abnormality of the veins and is nine times more common on the left side than on the right. This has been ascribed to the longer course of the left spermatic vein, to its entrance at a right angle into the renal vein, and to pressure of the descending colon. It is seen in young males between the ages of 15 and 25. The body of the testis is often smaller and softer than that of the opposite side, but this must be regarded as due to delayed descent, a history of which can usually be elicited, rather than a result of the varicocele. Atrophy of the testis is rare. (b) The *secondary* type may occur on either side and is due to venous obstruction by pressure of an abdominal tumour, usually of the kidney. It is seen in men over the age of 40 and is of rapid development.

Symptoms and Signs. There may be none, the condition being found during the routine examination of a candidate for one of the public services, or there may be an aching pain, aggravated by standing, and felt in the back and groin. In some cases there may be severe attacks of pain in the testis. The scrotum feels like a bag of worms and a characteristic thrill is imparted to the fingers on coughing, quite unlike the expansile impulse of a hernia. The varicocele diminishes in size on lying down, but light pressure over the external abdominal ring, by obstructing the venous return, causes it to become larger.

Treatment. Palliative. Most varicoceles give rise to no symptoms and require no treatment. The patient must be reassured and informed that the condition will probably improve as time goes on. If pain and discomfort are present, a suspensory bandage should be worn. Tonics, attention to the bowels, exercises, and cold baths are all of importance. Neurasthenia, which is commonly present, must be treated.

Injection (see page 3279).

Operative. This should be reserved for those cases in which the local condition is severe and neurasthenia is absent. If carried out indiscriminately the results are disappointing, the operation often being followed by orchitis, hydrocele, and degenerative changes in the testicle. Two operations are commonly performed—the inguinal or high, and the scrotal or low.

High Operation. The inguinal canal and the spermatic cord are exposed as for the radical cure of inguinal hernia, and the two anterior venous trunks isolated and ligatured with fine silk, in their continuity.

Low Operation. The spermatic cord is exposed just below the external abdominal ring and the venous plexus in front of the cord is isolated. About one inch is resected between ligatures, and the two cut ends are tied together.

Of these two operations the high is the simpler and better, there being less risk of inclusion of lymphatics and nerve filaments within the ligatures, the incidence of hydrocele and post-operative pain in the testicle being thereby diminished.

CHAPTER VII

DISEASES OF THE URETHRA

CONGENITAL DEFORMITIES

Congenital absence or complete obliteration of the urethra is very rare, and is associated with a rudimentary or absent penis. A patent urachus and other deformities are often present, or the bladder may open into the rectum or uterus. The child is either still-born or dies within a few hours.

Partial obliteration of the urethra may rarely occur at the glans, or in the penile, bulbous, membranous, or prostatic portions in that order of frequency. If the kidneys are active there will be dilatation of the bladder, ureters and renal pelvis; in other cases the child is usually still-born. The urachus may be patent or a communication exist between the bladder and the rectum or uterus, or there may be a penile fistula proximal to the obstruction.

Treatment. Cystotomy is usually indicated as an emergency measure, but in a few cases meatotomy or urethrotomy proximal to the obstruction has been successful. In the presence of an abnormal opening of the bladder, expectant treatment, though justifiable for a time, will eventually result in an ascending infection and a fatal termination.

Double Urethra This is a very rare condition, but may be accompanied by duplication of the penis, scrotum, or bladder, and other deformities. The second urethra may open in an abnormal situation.

Congenital Structure of the Urethra. This most commonly affects the external urinary meatus (pin-hole meatus), less commonly the junction of the penile urethra with the fossa navicularis, and still more rarely the membranous and prostatic urethra.

Symptoms and Signs. Meatal stenosis is a condition of great importance, and is frequently responsible for enuresis or for infections of the urinary tract, especially in children, in whom it should always be looked for. In adults it often prevents instrumentation until the opening has been either dilated or cut. The symptoms of meatal stenosis or narrowing in other parts of the urethra resemble those of stricture.

Treatment. In children a pin-hole meatus should be treated by progressive dilatation with meatal dilators. In adults the operation of meatotomy is performed (see page 3020).

Congenital narrowing in the more proximal parts of the canal is treated in the same way as a urethral stricture.

Congenital Dilatation of the Urethra. This is extremely rare and is evidenced by the presence of a pouch on the under-surface of the penile urethra, not associated

with congenital narrowing. The condition gives rise to frequency, dysuria, a poor stream and often dribbling.

The female urethra may be affected in a similar way.

Treatment. This consists of excision of the sac followed by a plastic repair. The skin and urethra are stitched up separately and a catheter is tied in for a few days.

Prolapse of the Urethra (see page 2222).

Urethrocele. This is an acquired condition, and is frequently seen in women who have borne children. It is due to some degree of uterine prolapse (see page 2241). A similar condition in the male sex has been described.

Hypospadias and Epispadias (see pages 3021 and 3025).

INJURIES AND RUPTURE

Injuries. (a) From within ; (b) from without.

Injury to the urethra *from within* may occur from the careless passage of an instrument, especially when this has been used for the investigation or treatment of urethral stricture. The majority of accidents are due to the use of a fine-pointed metal sound and it cannot be too strongly emphasised that the employment of such an instrument necessitates the greatest skill and gentleness. Usually the point pierces the urethral mucous membrane distal to the stricture, and in some cases may re-enter the urethra proximal to it (see fig. 1770). Subsequent attempts at micturition will cause the urine to enter the peri-urethral tissues and result in extravasation of urine.

Injury to the urethra *from without* is caused by gunshot wounds, stab wounds, and wounds by other weapons, and most commonly affects the penile or bulbous portions. If the wound is large and provides for the free exit of urine, extravasation is uncommon and hæmorrhage is the main factor requiring attention. Concomitant injury to the surrounding structures must be suitably treated. When the wound is small it should be enlarged, an attempt made to suture the urethra if this has been completely cut across, and a catheter tied in for four days. The wound is left open, and allowed to heal by granulation.

In very extensive injuries, the control of hæmorrhage is the first concern of the surgeon, after which all foreign material, such as cloth, fragments of bone, etc., must be removed as completely as possible. Suprapubic cystotomy is essential for the diversion of the urinary stream, and reconstruction of the urethra will have to be carried out at a later date.

Rupture of the Urethra. Rupture of the urethra may be complete or incomplete, and usually occurs either in the bulbous urethra (extra-pelvic rupture) or in the membranous urethra (intra-pelvic rupture) (fig. 1754). Of the two, the bulbous urethra is more frequently injured and results, in most cases, from a fall astride some projecting object such as a railing. Rupture of the membranous urethra is generally associated with a fractured pelvis. The first principle in treatment of all intra-pelvic and the majority of extra-pelvic ruptures is the immediate performance of suprapubic cystotomy under full anæsthesia, to divert the urinary stream and so prevent or check further extravasation.

Rupture of the Bulbous Urethra (extra-pelvic rupture). Symptoms and Signs. Rapidly increasing pain and swelling at the site of injury, following a fall or blow on the perineum, the appearance of blood at the external urinary meatus and, frequently, retention of urine.

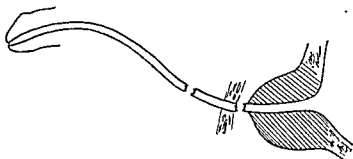


Fig. 1754.—INTRA AND EXTRA-PELVIC RUPTURE OF URETHRA.
(After Wheeler, "Proc. Roy. Soc. Med.")

Treatment. Under no circumstances should the patient attempt to micturate if urethral rupture is suspected. Subsequent procedures should only be carried out in an operating theatre under general anæsthesia and with full aseptic precautions.

The external genitals are cleansed and painted with 3 per cent picric acid in spirit. A No. 10 English gum elastic bicoudé catheter is inserted into the urethra with its beak in contact with the roof and an attempt made to pass it through the damaged portion of the canal into the bladder with the utmost gentleness. If it slips in with ease an *incomplete rupture* of the urethra may be assumed; under these circumstances it is sometimes justifiable to leave it as an indwelling catheter, and to do nothing more than wash out the bladder with acriflavine 1 in 8000. In most cases, however, it is probably wiser to make an incision into the perineum and urethra on to the catheter, in order to evacuate most of the extravasated blood, and sometimes urine,

and to remove any pulped peri-urethral tissues. Failure to do this is mainly responsible for the subsequent formation of a traumatic stricture.

After-Treatment. The bladder is washed out twice daily through the catheter, which is left in position for four days. The perineal incision is allowed to heal by granulation. Anterior urethroscopy is carried out in not less than three weeks and is followed by the intermittent passage at first of meatal sounds and later of a Kollmann dilator to prevent the formation of a stricture.

In *complete rupture* of the bulbous urethra, the catheter can rarely be passed beyond the site of injury, and will only draw off a small quantity of blood. In this case the abdomen is cleansed and painted with 3 per cent picric acid in spirit and suprapubic cystotomy is performed. A retrograde catheter is passed through the internal urinary meatus to the site of injury and another through the external urinary meatus.

The patient is placed in the lithotomy position, and an incision is made through the perineum on to the catheters until the urethra is exposed. Extravasated blood and urine and any pulped peri-urethral tissues are removed. The ends of the torn urethra are identified and united by two catgut stitches along the roof. All bleeding points are *ligatured*, the two catheters are withdrawn, the wound is *lightly packed* with gauze, the bladder incision closed round a suprapubic catheter, and a small prevesical drain inserted. No catheter is tied into the urethra as this may predispose to the subsequent formation of a traumatic stricture.

After-Treatment. Anterior urethroscopy is performed after three weeks, and is followed by intermittent dilatation of the urethra, at first with steel sounds and later with a Kollmann dilator to prevent the formation of a traumatic stricture, which is a common sequel. The perineal wound is allowed to heal by granulation, and the suprapubic tube is removed in not less than fourteen days. The cystotomy wound should be healed by the end of three weeks.

Rupture of the Membranous Urethra (intra-pelvic rupture). Symptoms and Signs. Signs of a fractured pelvis are present together with complete inability to micturate. Blood may be seen to ooze from the external urinary meatus. Extravasation of urine occurs into the prevesical space, as will be rendered evident by the appearance of a gradually increasing swelling which can be seen and felt in the hypogastrium. Pain and shock are marked features, and muscular rigidity of the lower abdomen is present. It is impossible to distinguish rupture of the membranous urethra from extra-peritoneal rupture of the bladder, except by open operation which should be immediately carried out.

Operation. The passage of a catheter as an aid to diagnosis should only be carried out in an operating theatre under strict aseptic precautions and with the patient under general anæsthesia. After adequate cleansing and painting of the suprapubic and genital regions with 3 per cent picric acid in spirit, suprapubic cystotomy is performed, when the diagnosis of rupture of the membranous urethra is confirmed by finding a distended bladder which excludes extra-peritoneal rupture of the viscus. Suture of the divided urethra is impossible, and an attempt must be made to pass a No. 21 Charrière rubber catheter in a retrograde direction through the internal urinary meatus along the urethra.

In *incomplete* rupture this is usually possible, and when its point appears at the external urinary meatus, the tip of a second rubber

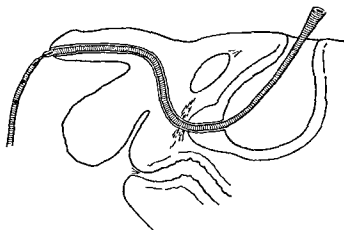


Fig. 1755.—CATHETER ATTACHED TO RETROGRADE CATHETER.
(After Wheeler, "Proc. Roy. Soc. Med.")

catheter, of similar size but with several lateral openings, is attached to it by means of a piece of thread (fig. 1755). On withdrawing the retrograde catheter from the cystotomy wound, this second catheter is pulled along the urethra into the bladder (fig. 1756).

In *complete* rupture there is rotation of the bladder backwards due to tearing of the pubo-prostatic ligaments, and consequent wide separation of the ends of the divided urethra (fig. 1757).

A retrograde catheter is passed as far as it will go through the prostatic urethra, and then held in position by an assistant. The patient's legs are flexed, separated, and held by two nurses. A long median incision is made in the perineum, all blood clot is cleared away, damaged tissues are excised by sharp dissection, and bleeding is controlled. By gentle pressure on the catheter by the assistant, its tip is made to emerge through the ruptured urethra into the perineal

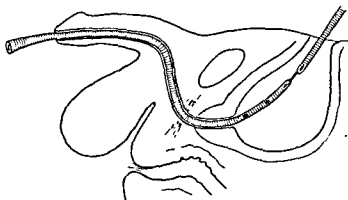


Fig. 1756.—CATHETER PULLED INTO BLADDER BY RETROGRADE CATHETER.
(After Wheeler, "Proc. Roy. Soc. Med.")

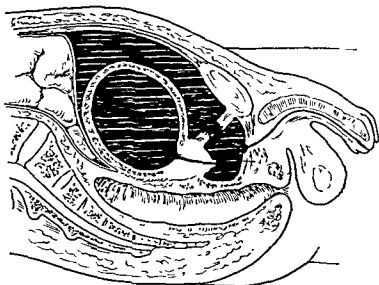


Fig. 1757.—INTRA PELVIC RUPTURE OF URETHRA.
(After Barley and Love.)

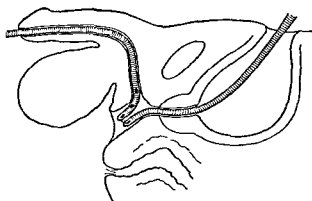


Fig. 1758.—RETROGRADE AND PENILE CATHETERS UNITED
IN PERINEAL WOUND.
(After Wheeler, "Proc. Roy. Soc. Med.")

wound. A No. 21 Charrière rubber catheter with several lateral openings is passed through the external urinary meatus up the urethra, until its tip also appears in the wound (fig. 1758). The ends of the two catheters are tied together with thread and the retrograde catheter is withdrawn through the cystotomy wound, until the tip of the other is seen in the bladder.

In either incomplete or complete intra-pelvic rupture of the urethra, once an indwelling catheter has been inserted, a long thread is attached to its vesical end and is brought out through a medium-sized suprapubic tube around which the bladder is closed (fig. 1759). Two tubes are placed on either side of the bladder in order to drain the peri-vesical tissues, after which the wound is closed in the usual manner.

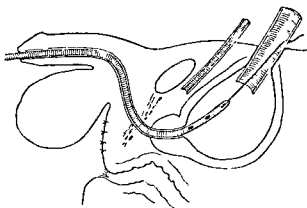


Fig 1759.—CATHETER IN POSITION AND ATTACHED TO SUPRAPUBIC TUBE.

(After Wheeler, "Proc. Roy. Soc. Med.")

Some surgeons complete the operation by closing the perineal wound in layers. Others prefer to pack it lightly with gauze smeared with B.I.P.P., healing taking place by granulation.

After-Treatment. Bladder irrigation is carried out twice daily through the indwelling catheter, which is changed every four days by stitching a fresh one to the meatal end of the indwelling one and pulling on the thread which was left attached to the end lying in the bladder. The paravesical tubes are removed on the fifth day and both indwelling catheter and suprapubic tubes on the fourteenth. No instrument is passed until the perineal and suprapubic wounds have healed, which should take about five to six weeks. Intermittent dilatation, at first with moderate-sized steel sounds and later with a Kollmann dilator, should be carried out, though the tendency to stricture formation after intra-peritoneal rupture is far less than after rupture of the bulbous urethra.

URETHRAL SHOCK AND URETHRAL FEVER

Urethral Shock. Some degree of faintness is sometimes observed in a nervous patient on whom instrumentation of the urethra is being carried out for the first time. It usually passes off quickly when the head is lowered or a glass of cold water is drunk, or a small capsule of ammonia wrapped in gauze is broken under the patient's nose. Urethral shock is very rare and of an extremely serious nature, probably being due to some reflex nervous condition. During or immediately after instrumentation, however gently performed, the patient shivers, feels faint, becomes blanched, sweats, and gasps for breath. The temperature is sub-normal, the pulse rapid and feeble, and there is a marked degree of shock. Unconsciousness may supervene, respiration cease, and death occur in a large number of such cases.

Treatment. Artificial respiration combined with stimulants may revive the patient. Post-mortem examination of the urethra usually fails to reveal any evidence of trauma.

Urethral Fever (catheter fever). This condition is due to septic absorption through an abrasion of some part of the urethra, usually when obstruction exists, due to enlarged prostate or stricture. The abrasion may result from the passage of a catheter or other instrument, or from internal urethrotomy or prostatectomy. The infection is usually introduced by the passage of septic urine over the raw area, either at the first act of micturition after catheterisation, or after the natural passage of urine about 10 to 14 days after prostatectomy. It is very rare for both abrasion and infection to be caused by instrumentation.

Symptoms and Signs. These appear within a few hours of instrumentation and begin with a sensation of chilliness and headache, together with a rise of temperature rapidly reaching 103° to 105° F., or a definite rigor followed by a sudden fall of temperature, which leaves the patient exhausted and in a profuse cold sweat. The pulse is rapid and feeble, and the patient feels and looks extremely ill, with an ashen grey colour.

Suppression of urine may occur from ascending infection or from profound toxæmia, but is more common when the kidneys are already diseased. As a rule there is complete recovery within a few hours, except for some degree of exhaustion.

Treatment. Prevention of urinary fever consists of gentleness and skill in all instrumental procedures, especially when infection is present. Strict asepsis is essential and all instruments must be efficiently sterilised. The use of urinary antiseptics should precede and follow instrumentation, and lavage of the bladder should be carried out at the time of instrumentation.

When urinary fever has occurred, the patient should be put to bed and given large doses of alkalis and fluids, such as Contrexéville, Vittel, or barley-water. The bladder should be washed out with a disinfectant such as acriflavine 1 in 8000. Occasionally it will be found necessary to divert the urinary stream by an indwelling catheter or sometimes by suprapubic cystotomy.

The injection of S.U.P. 36 has very rarely been followed by good results. The causal urinary infection must receive appropriate treatment.

STONE IN THE URETHRA

Two types of calculus are found in the urethra, the commonest variety being a stone which has formed in the upper urinary passages or bladder and then become impacted in the urethra. In rare cases a primary urethral calculus may be formed by deposition of phosphatic crusts on a raw surface proximal to some lesion such as urethral stricture. Urethral calculus occurs in the male subject only, and is one of the causes of retention in boys between 5 and 15 years. The sites of impaction in order of frequency are: (1) the external urinary meatus, which is the narrowest part of the urethra; (2) the membranous urethra; and (3) the penile urethra immediately proximal to the fossa navicularis.

Symptoms and Signs. A previous attack of renal colic is frequent in the case of a secondary urethral stone, suggesting its origin in one or other kidney. During micturition there is a sudden intense pain, arrest of the flow, and the passage of a few drops of blood, which may be followed by complete retention. In adults with urethral stricture, attacks of difficulty or retention may occur from impaction of the calculus behind the stricture. In the case of primary calculus a stricture is almost certainly present, and symptoms of frequency, difficulty, dysuria, pyuria, and urethral discharge become superadded. The stream is slow, and complications such as peri-urethral suppuration or urethral fistula may occur.

Diagnosis. This is made by a history of a past attack of renal colic and a consideration of the symptoms. Routine examination may reveal the presence of a calculus near the external urinary meatus or in the bulbous portion of the canal. After cocainising the urethra a catheter, when passed, may encounter an obstruction. A metal sound will produce a characteristic click, and anterior urethroscopy reveal a stone. If necessary, an X-ray photograph will confirm the diagnosis.

Treatment. A calculus impacted at or near the meatus is extracted with forceps under general anæsthesia after meatotomy has been carried out. In some cases, if this is impossible, the stone should be pushed back into the bulbous urethra and removed through a small median incision. If impacted in the membranous urethra an attempt should be made to push the stone back into the bladder, when it is crushed by litholapaxy and the fragments evacuated. If this is impossible, a small perineal incision is made over the stone which is then extracted. A catheter is tied in for four days.

Primary calculi complicating urethral stricture usually require removal by external urethrotomy, their recurrence being prevented by appropriate treatment of the causal condition.

FOREIGN BODIES

These are sometimes found in the urethra, usually as a result of their introduction by the patient. In many cases they are ejected by the urinary flow, but may occasionally find their way into the bladder. If they become impacted in the urethra the symptoms are similar to those of an impacted stone. Phosphatic incrustation rapidly occurs and peri-urethral suppuration or abscess may result. The commonest situation for impaction is the fossa navicularis or bulbous urethra, but the prostatic portion is occasionally involved.

Diagnosis. This is made by a consideration of the symptoms, a routine examination and the performance of anterior urethroscopy.

Treatment. An impacted foreign body requires similar treatment to that of an impacted calculus. In the case of a pin, the head usually lies in the urethra while the point is embedded in its wall distally. Under general anæsthesia the point should be made to emerge through the urethra and skin, and the head reversed and pushed out of the meatus.

URETHRAL STRICTURE

Stricture of the urethra occurs, as a rule, between the ages of 25 and 45 years, and is, in the vast majority of cases, of inflammatory origin, but in rare cases may be congenital or traumatic. Inflammatory stricture is a result of chronic urethritis, usually of gonococcal origin, and though at one time regarded to be exclusively a disease of the male sex, has been shown to occur not uncommonly

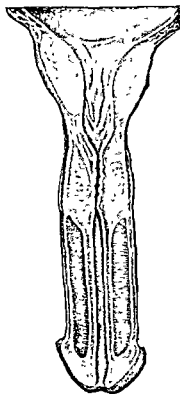


Fig. 1760.—URETHRAL STRICTURE.

in females also. It is due to imperfect treatment of the urethritis, and its formation is accelerated by meatal stenosis, phimosis, or by alcoholic or sexual excesses. During an attack of gonorrhœa the glands of Littre and other urethral follicles become invaded by the gonococcus and other organisms, which bring about some degree of obliteration and surrounding peri-glandular inflammation, resulting in the formation of a soft infiltration. Under appropriate treatment this becomes absorbed, but in other cases fibroblasts appear and are later converted into fibrous tissue (hard infiltration), which subsequently contracts with the formation of a stricture (fig. 1760). Occasionally the corpus spongiosum is involved, when longitudinal as well as circular contraction will occur, resulting in the condition of *chordee*, the penis being bent with its concavity downwards like a bow, the stretched urethra resembling the string. Metaplasia of the columnar mucous lining into stratified squamous epithelium takes place, and desquamation of its superficial layers occurs from time to time with the formation of urethral flakes which are passed in the urine and may persist for years. These inflammatory processes are very slow, and years may elapse before a stricture is fully formed.

A stricture may affect the whole circumference of the urethra or may involve only the floor, the roof, or its lateral walls.

It is described in order of increasing severity under the headings of "congestive stricture," "soft infiltration," "hard infiltration,"

and "fibrous stricture," but these are merely steps in the same pathological process. Strictures may also be described by their shape as linear, annular, tortuous, or bridle—the terms being self-explanatory, or by their consistency, such as cartilaginous or resilient, and finally by their inability to allow the passage of an instrument (impassable) or urine (impermeable). The urethra behind the stricture is usually inflamed and dilated. Ulceration and peri-urethral suppuration may occur, sometimes with the formation of a peri-urethral abscess which may rupture into the urethra, but which occasionally bursts externally with the production of a urinary fistula or into the peri-urethral tissues causing extravasation of urine. Varying degrees of prostatitis and vesiculitis are always present, and these may give rise to epididymitis. As a result of infection and back pressure, trabeculation and later dilatation of the bladder occur with the formation of diverticula. Chronic cystitis and residual urine, with consequent alkaline decomposition, may result in the formation of stone, and acute retention occur. Continued back pressure and infection will eventually cause dilatation and infection of the kidneys, and result in chronic pyelonephritis and, sooner or later, in renal failure. Extra-urinary conditions, such as gonorrhœal rheumatism, fibrositis and iritis, are occasionally present.

Gonococcal strictures are usually multiple (75 per cent), the majority (66 per cent) being situated in the bulb, while the remainder are in the penile portion. The walls of the prostatic and membranous urethra are never affected.

Symptoms and Signs. Symptoms of chronic urethritis, which may vary from the presence of urethral threads in the urine to a persistent purulent discharge at the meatus (gleet), are always present. In a stricture of large calibre these may be the only manifestations of its presence other than a history of a past attack of gonorrhœa. When contraction has progressed to a calibre smaller than the size of the external meatus other urinary symptoms are superadded. The stream becomes small and thin, but retains its force of projection, and straining is found to assist the act of micturition.

In late cases complicated by prostatitis, vesical dilatation and residual urine, the symptoms resemble those of bladder-neck obstruction. The force of projection is feeble, there is difficulty before micturition, and dribbling afterwards is common. Frequency and dysuria due to chronic posterior urethritis or cystitis are present, and pain is frequently felt at the site of the stricture, at the external abdominal rings, and over one or both kidneys. Painful ejaculations and retention of semen in the

bladder occur. Retention of urine may result from congestion of the mucous membrane near the stricture, and commonly follows a chill or some dietetic, alcoholic or sexual indiscretion. It may be complete or incomplete, a few drops of urine being passed at frequent intervals. Suprapubic pain varies according to the previous condition of the bladder. If acute retention becomes superimposed on chronic, pain may be almost entirely absent. False incontinence due to chronic distension of the bladder with overflow is sometimes observed. Dilatation and infection of the kidneys produce characteristic symptoms and end in renal failure.

Diagnosis. This is suggested by a consideration of the symptoms of chronic urethritis, diminution of the size of the stream without loss of projection, difficulty which is helped by straining, and a past history of gonorrhœa. Routine examination confirms the presence of urethritis, as shown by urethral threads or urethral discharge, and often chronic infection of the prostate and vesicles or epididymes. Rectal examination will help to exclude bladder-neck obstruction due to hypertrophy or fibrosis of the prostate.

During the introduction of a local anæsthetic it will often be noticed that the capacity of the urethra is reduced, there being apparently some degree of obstruction to the solution which can only be made to enter the urethra slowly. In stricture of small calibre the catheter will be obstructed at its site, and smaller sizes must be passed until one is found which can be passed through its lumen. Obstruction due to the presence of a deeper stricture will frequently be encountered, and may necessitate the use of an even smaller catheter, or may prove impassable, when resort must be made to a guide and follower, as described under "Treatment."

Anterior urethroscopy will confirm the presence of a stricture, which is seen as a white septum with a dark spot concentrically or eccentrically placed representing the narrowed lumen of the canal, but will give no information regarding the presence of a deeper one, unless the first can be negotiated by the urethroscopic tube.

Spasmodic stricture is usually due to posterior urethritis, and presents no obstruction to a catheter after efficient cocainisation of the canal.

Obstruction due to prostatic hypertrophy or fibrosis occurs in older people, and is accompanied by the characteristic symptoms and signs. Hypertrophy of the prostate does not cause obstruction to a catheter, though a characteristic lengthening of the posterior urethra is frequently

shown by the increased distance the tip of the catheter has to traverse before the bladder is reached and a flow of urine obtained. Prostatic fibrosis may give rise to some degree of difficulty in the passage of a catheter, but the obstruction will not be felt until its tip has reached the prostatic urethra.

Treatment. The prevention of stricture consists in adequate treatment of the causal attack of gonorrhœa, which should not be regarded as cured until an examination of the urine, after at least three prostatic and vesicular massages, is found to be free, not only from the gonococcus but also from all organisms and pus cells. Moreover, in every case the dilatability of the urethra should be tested by means of Kollmann's dilator, this checked by a careful examination with the anterior urethroscope, and a search made for any infected follicles which may have escaped treatment.

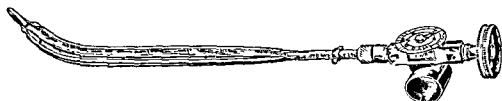


Fig. 1761.—KOLLMANN'S DILATOR. (AUTHOR'S MODIFICATION.)

Treatment of Strictures of Large Calibre. It is impossible to cure a stricture of large calibre by means of bougies or steel sounds, as their sizes are limited by the external urinary meatus which is the narrowest part of the urethra. The essence of successful treatment depends upon each portion of the urethra being dilated to a degree higher than its normal limits, and this will bring about gradual absorption of the fibrous tissue which has formed. Treatment is carried out at weekly intervals under local anæsthesia by means of Kollmann's antero-posterior dilator, which consists of a curved metal stem covered by four rounded blades (fig. 1761). By rotating a milled screw at the top of the shaft, the blades are evenly projected along their whole length to an extent varying in different parts and based on the normal differences of urethral calibre, the degree of dilatation being registered by a pointer which moves over a circular scale. The terminal $\frac{3}{4}$ -inch of the instrument does not dilate, but receives the insertion of the four blades. When correctly in position it should lie just within the membranous urethra. The proximal ends of the blades are inserted into a collar encircling the shaft at a point corresponding to the external urinary meatus. When closed, the instrument is 20° Charrière in size, and

when fully opened its maximum dilatation at a point corresponding to the bulb is 45° . The use of local anæsthesia, which abolishes pain, necessarily emphasises the importance of the following points :

(1) The same instrument should always be used on any given patient, otherwise the results of treatment will be irregular and confusing owing to the variability of dilators.

(2) The instrument should be kept in perfect working order and its joints free from rust.

(3) The surgeon must know his instrument in order that his sense of touch may differentiate resistance due to the instrument from resistance due to urethral stricture.

When the patient has been prepared and the urethra anæsthetised, he lies comfortably on a couch with the head well supported. The

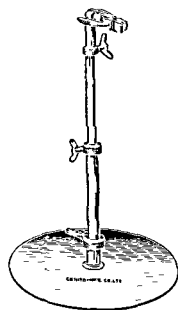


Fig. 1762.—CLAMP FOR SECURING
KOLLMAN'S DILATOR.

instrument, warmed and well lubricated with lubafax, is passed until the tip just engages in the membranous urethra, in which position it is fixed by a clamp placed between the thighs (fig. 1762). The milled screw is turned and any resistance noted. The normal urethra should dilate readily without resistance to 40° Charrière, and then at the rate of 1 degree every two minutes until 45° Charrière is attained, this all being effected without the slightest discomfort or bleeding.

As soon as resistance is encountered the scale is read and charted. After an interval of three to five minutes, dilatation is continued until resistance is again noticed.

Exact directions for the extent of treatment cannot be laid down, as this depends on the consideration of each individual stricture. Broadly speaking, the surgeon should be well content with an increase of 2 degrees at each sitting for strictures under 30° Charrière, 1 degree between 30° and 40° , and $\frac{1}{2}$ a degree over 40° .

Treatments should be carried out at weekly intervals, and be followed by complete irrigation of the bladder with 1 in 8000 acriflavine, or 1 in 8000 oxycyanide of mercury, according to whether the urine is cloudy or clear.

As a rule, treatment is progressive and satisfactory up to about 35 degrees and after 38 degrees, but it often happens that some difficulty from bleeding is experienced between these points. This stage should be regarded as the most critical from the point of view of ultimate cure and, when successfully overcome, future treatment of the stricture is usually straightforward.

When full dilatation has been reached on three consecutive occasions without any appreciable resistance before 40° Charrière and in the absence of bleeding, the intervals between treatments are gradually extended until finally the patient attends once yearly as a precautionary measure, and the stricture may be regarded as cured.

Treatment of Strictures of Small Calibre, i.e. under 20° Charrière. In these strictures preliminary treatment must be carried out until the urethra attains a calibre of over 20° Charrière, when treatment is continued with Kollmann's dilator until a cure is obtained. It must be clearly understood that the following methods can, in themselves, in no circumstances bring about a cure.

(1) Instrumental treatment: (a) Intermittent dilatation by gum elastic bougies or curved metal sounds; (b) guides and followers; (c) continuous dilatation by catheters.

(2) Operative treatment: (a) Internal urethrotomy; (b) external urethrotomy; (c) suprapubic cystotomy followed by (i) instrumental dilatation; (ii) retrograde catheterisation; (iii) excision of the stricture.

INSTRUMENTAL TREATMENT

(a) *Intermittent Dilatation by Bougies* (fig. 1763). Dilatation by gum elastic bougies should be adopted as a routine treatment until a calibre of over 20° French has been obtained. A bougie is about 13



Fig. 1763.—GUM ELASTIC BOUGIE.

inches long, tapered at its distal half, and sizes from 6° to 27° Charrière should be at hand. Sterilisation is effected by hanging the bougies in closed jars containing calcium chloride and formalin tablets for 12 hours.

The patient is directed to pass all his water and lie on a couch. The penis is cleansed, isolated, and anæsthetised. A bougie is selected, lubricated with lubafax, and gently passed into the urethra. The penis with retracted prepuce is held behind the glans by the second and third fingers and put on the stretch. If obstruction is encountered a smaller bougie is used until the canal of the stricture can be passed, when the bougie is withdrawn and a larger one inserted, no more than three being passed at one sitting. Urinary antiseptics, such as hexamine before meals and an acid mixture after, are prescribed for three days before instrumentation, after which alkalis are given for a similar period. 10 grs. of empirin compound and 4 grs. of quinine hydrochloride, if taken immediately, are a useful precaution against catheter fever after the treatment. Intermittent dilatation is carried out at weekly intervals until Kollmann's antero-posterior dilator can be passed.

Steel Sounds (see fig. 1641). Dilatation by metal sounds is sometimes advocated for strictures of medium calibre, but should be reserved for those whose density prevents satisfactory progress with gum elastic bougies. A steel sound, smaller than necessary, should be used first and the exact state of affairs determined by feel. This includes the exact localisation of the stricture, its extent, and the presence of a second or even a third. The penis is well stretched during the whole procedure and the sound kept accurately in the mid-line, with the shaft lying almost parallel to the patient's abdomen. Only when all the strictures have been negotiated does its tip come to lie opposite the opening in the triangular ligament. At this point tension on the penis is somewhat relaxed and the tip of the sound gently coaxed into the membranous urethra, after which its handle is vertically depressed, when it will pass on into the bladder with resulting dilatation of the strictures by its tapering shaft.

(b) *Guides and Followers* (fig. 1764). These are indicated when the stricture is too small or too irregular to allow the passage of a bougie.



Fig. 1764.—GUIDE AND FOLLOWER.

A *guide* is a very small filiform gum elastic bougie, having a mount at one end which is hollow and threaded on the inner side. It is $12\frac{1}{2}$ inches long and rigid enough to pass through the urethra without

curling up, yet supple enough to curl up in the bladder after passing through the stricture.

The patient having been prepared and the urethra anaesthetised, the sterilised guide is taken and about $\frac{1}{4}$ inch of its tip bent to an angle of 30° . Traction is made on the penis, and the guide, well lubricated, is gently passed down the urethra, being rotated from side to side to prevent its point from being caught in any of the lacunæ. When the face of the stricture is reached, an attempt is made to engage the point in its canal. No force of any kind is permissible or a false passage may easily be made. In many cases the procedure may take half an hour or more. The position of the point of the guide should be altered very slightly between each movement of insertion and withdrawal. Entry of the point of the guide into the canal of the stricture is heralded by a sudden lack of resistance, after which it is again gently pushed onwards until the face of a second stricture may be reached. This is negotiated with the same care as the former, and there remains only its passage through the posterior urethra into the bladder. Sometimes this proves to be the most difficult part of the procedure, as the point of the guide is apt to become caught up in one or other of the prostatic lobes or ducts, and much patience and rotation of the guide may be necessary before a successful issue is obtained. Several procedures may help in the passage of a guide through a stricture: (1) The guide is withdrawn, the angle of the terminal $\frac{1}{4}$ inch altered, and the process repeated. This can be tried again and again. (2) The guide is passed and two or three other guides are inserted alongside it; each is manipulated in turn until one of them engages in the canal of the stricture. (3) The urethra distal to the stricture is fully distended with olive oil, which is retained by a penile clamp, and one guide or more is passed through the meatus and manipulated as before. The oil flattens out all the urethral folds and tends to open up the canal of the stricture. (4) An anterior urethroscope is inserted into the urethra and an attempt made to pass the guide by direct vision. If bleeding has been produced by previous attempts, the last method must be used with caution, as there is some danger of embolism.

A *follower* is a gum elastic bougie which has a projecting metal pin at one end which is threaded and can be screwed right home into the hollow mount of the guide. A sterile follower of small size is selected, screwed right into the guide and the point tested by a firm pull. This is of the utmost importance as failure to do so may result in the guide being left in the bladder on withdrawing the follower. The follower is well lubricated and gently pushed into the urethra, traction being

made meanwhile on the penis. Considerable force may be necessary to pass the follower through the stricture, but in expert hands this is quite safe as the guide leads the way. The follower is withdrawn and replaced by a larger size, and the procedure repeated, not more than three sizes being passed at one sitting. Intermittent treatment is carried out at weekly intervals until a calibre of 15° Charrière is obtained, when the process is continued by means of bougies.

(c) *Continuous Dilatation by Catheters.* Continuous dilatation by an indwelling catheter is employed in certain cases of very dense stricture in which no progress can be made by intermittent methods. It constitutes the most rapid instrumental means of dilatation, but necessitates confinement to bed, the urine flowing directly from the catheter into a vessel. By tying in a larger-sized catheter each day the stricture can be dilated from 6° to 24° Charrière in a week, when intermittent dilatations with Kollmann's dilator are continued until a cure is obtained.

OPERATIVE TREATMENT

Indications. (1) Inability to pass a guide in cases of retention. (2) Inability to pass a guide on three consecutive occasions. (3) In certain cases where the stricture is intolerant of dilatation after skilled passage of instruments, as shown by rigors, hæmorrhage, retention of urine, or epididymitis. (4) Peri-urethral extravasation. (5) In some cases of peri-urethral abscess. (6) Stricture complicated by certain diseases of the bladder or prostate, e.g. acute cystitis, enlarged prostate, or some cases of vesical stone. (7) In the presence of symptoms of renal failure. (8) As a preliminary to excision of stricture. (9) In certain complications of treatment, i.e., the breaking off of a guide and its retention in the bladder.

The operations available for the treatment of stricture are: (a) internal urethrotomy; (b) external urethrotomy; and (c) suprapubic cystotomy. The last mentioned is in some cases followed by excision of the stricture, but more commonly by instrumental dilatation by one of the methods already described, or by retrograde catheterisation. It cannot be too strongly emphasised that operation should only be performed as a last resort and never considered until instrumental methods have failed on several occasions, or unless one of the indications enumerated above is present.

The great disadvantage of any direct operative attack on a stricture by the urethrotomies is that this must invariably be followed by

instrumental treatment in order to bring about a cure, which is often considerably delayed by the additional scar tissue which results from the incision and which becomes superimposed on the fibrous tissue of the original stricture.

(a) *Internal Urethrotomy.* This depends for its performance on the ability to pass a guide to which the shaft of the instrument is screwed, and consists of cutting through the stricture from before backwards on the roof of the canal by means of a guarded knife (urethrotome) which slides along the shaft. The best variety of instrument is Thomson-Walker's modification of a Maisonneuve (fig. 1765).

Pre-operative Preparation. For ten days the patient is given urinary antiseptics in order to diminish infection as far as possible. The external genitals are prepared by shaving and washing with anti-

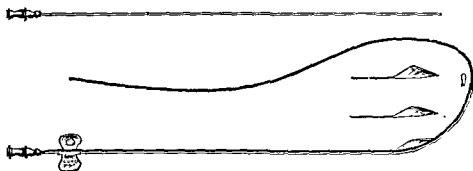


Fig. 1765.—THOMSON-WALKER'S MODIFICATION OF MAISONNEUVE'S URETHROTOME.

septic lotion in the usual way and the urethra is thoroughly irrigated with acriflavine 1 in 8000.

Anæsthetic. General anæsthesia such as gas and oxygen preceded by intra-rectal avertin is essential.

Operation. The external genitals are thoroughly painted with 3 per cent picric acid in spirit and the parts isolated by sterile mackintoshes and towels. A filiform guide is passed to the face of the stricture and made to engage with its canal. This procedure may take a little time and has been fully described on page 3081.

The metal staff of the urethrotome is screwed on to the guide, the union firmly tested, and the instrument, well lubricated, gently passed into the bladder, which will cause the guide to coil up in its cavity. The staff of the urethrotome is steadied by the hands of an assistant holding the two lateral wings. The triangular knife is lubricated and introduced

into the groove of the staff. The penis is held with the left hand just behind the glans and tension is made on it. The meatus is pulled well away from the knife to allow it to enter into the urethra, whereupon it is gently passed to the face of the stricture which is divided on its roof by means of a sharp push.

If a second stricture is present, it is divided in a similar manner.

The knife is next withdrawn, a reverse cut made through the stricture or strictures should resistance be felt, and the knife then removed altogether, after which the staff and guide are withdrawn.

A large Lister steel sound (15/18 English) is passed into the bladder, a meatotomy being performed if necessary.

A No. 14 English coudeé gum elastic catheter is tied in (see page 2974), after withdrawing the sound, and the operation is completed by washing out the bladder with acriflavine 1 in 8000 through the catheter.

After-Treatment. The bladder is washed out twice daily through the catheter for three days, when the latter is removed, and the urethra is irrigated every day for a week, after which the patient is allowed up.

Some degree of urethral fever is common after removal of the catheter, and is due to septic absorption of the infected urine from the raw area.

At the end of a fortnight instrumental dilatation is begun by means of large steel sounds passed at weekly intervals, this being followed by the use of Kollmann's dilator until a calibre of 40° Charrière has been obtained, when the intervals between treatment are gradually extended until the patient attends once yearly as a precautionary measure.

Difficulties and Complications. (1) If it is found to be impossible to pass a guide by any of the methods described on page 3081, internal urethrotomy cannot be carried out.

(2) On withdrawing the staff the guide may be left behind in the bladder. This is due to carelessness in testing the union before insertion or to the use of an old or faulty guide. In such a case the guide should at once be removed by an instrument such as a Young cystoscopic rongeur.

(3) Failure to pass a metal sound. This is due to incomplete division of the stricture, which may necessitate a second attempt. It is usually caused either by a blunt knife, or by too gentle a cut which merely stretches and does not divide the stricture.

(4) *Hæmorrhage.* This is usually easily controlled by the presence of a large indwelling catheter. Should it be insufficient, firm pressure over the site of the stricture must be made by means of a large perineal pad and a T-bandage, and the patient given an injection of 20 cc. of coagulen-ciba into the buttock. In extreme cases an incision is made in the perineum, a large catheter passed into the bladder through the wound, the bleeding points picked up, if possible, and tied, and the wound round the catheter packed with antiseptic gauze.

(5) *Urethral Fever.* This may occur after removal of the catheter but usually responds to urethral irrigation. In some cases, however, re-introduction of the catheter and washing out of the bladder is necessary to prevent further absorption of infected urine, and occasionally the urinary stream must be diverted by suprapubic cystotomy.

(6) *Epididymitis.* This troublesome complication may occasionally occur and is discussed on page 3047.

(7) *Renal Infection and Anuria.* Post-operative pyelonephritis rarely occurs unless there has been pre-existing infection of the kidneys, which emphasises the importance of a preliminary investigation of the renal function. Should this be much diminished, the best operative treatment consists of suprapubic cystotomy, followed by instrumental dilatation of the stricture at a later date.

(b) *External Urethrotomy.* (Wheelhouse's operation.) *Indications.* This operation may be carried out when inability to pass a guide contra-indicates internal urethrotomy and instrumental dilatation. As a rule it is followed by much fibrosis with consequent delay in the ultimate cure, and is unsatisfactory in its results. In most cases, if all attempts to pass a guide both from the urethra and from the bladder have failed, it is much better to attempt excision of the stricture some weeks after suprapubic cystotomy.

Special Instruments Required. (1) Wheelhouse's staff (fig. 1766), and (2) Teale's probe-pointed gorget (fig. 1767).

The principle of the operation consists in the passage of Wheelhouse's staff to the face of the stricture, incision of the urethra on the groove of the staff, and the slitting up of the stricture after passing or forcing a fine probe through it.



Fig. 1766.—WHEELHOUSE'S STAFF.



Fig. 1767.—TEALE'S PROBE POINTED GORGET.

Operation. The patient is placed in the lithotomy position, the external genitals are thoroughly painted with 3 per cent picric acid in spirit, and the parts isolated by sterile mackintoshes and towels. Wheelhouse's staff is introduced into the urethra and passed down to the face of the stricture. The staff is held by an assistant, an incision is made into the perineum in the mid-line, and the urethra is opened on the groove of the staff for a length of about 1 inch distally from a point one quarter of an inch away from the stricture. The edges of the urethral incision are transfixed with No. 1 catgut threaded on curved round-bodied needles, whereby adequate retraction from side to side is obtained. The staff is reversed so that the hook presents into the wound, and is made to retract the upper angle of the opened urethra (fig. 1768).

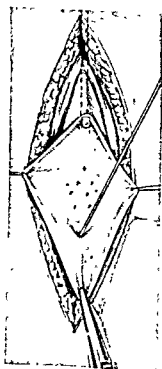


Fig 1768—EXTERNAL URETHROTOMY.

The urethra is thus held fully open with its lumen preserved for a quarter of an inch immediately in front of the stricture.

A fine probe-pointed director is next inserted into this portion of the urethra and an attempt made to pass its point through the stricture towards the bladder.

By everting the stricture slightly by means of finger pressure on the perineum behind it, this manœuvre is greatly facilitated.

A deliberate incision is made throughout the whole length of the stricture on to the groove in the director until the dilated proximal urethra is laid open.

Teale's probe-pointed gorget is introduced into the groove of the director and is passed into the bladder, its

entry usually being heralded by an immediate gush of urine.

The director and staff are withdrawn and a No. 14 English gum elastic catheter is passed through the external urinary meatus along the urethra until its point appears in the wound. From here it is gently pushed into the bladder, being guided by the hollow of Teale's gorget, which is later removed.

A few No. 0 catgut sutures are inserted into the walls of the normal urethra distal to the stricture, to approximate its edges over the catheter. The strictured portion of the urethra and the remainder of the perineal wound are left unsutured and are lightly packed with gauze soaked in paraffin and flavine 1 in 1000.

The catheter is tied in in the usual way, its correct position being ensured after washing out the bladder with acriflavine 1 in 8000.

After-Treatment. The bladder is washed out twice daily for four days through the catheter, which is then removed and the urethra irrigated daily with acriflavine 1 in 8000 for ten days, after which time the patient is allowed up. After removal of the catheter the perineal packing should be changed daily by allowing it to soak off in a hot sitz bath.

Intermittent instrumental dilatation is begun at the end of a fortnight and continued until 40° Charrière has been attained with Kollmann's dilator, when the intervals between treatment are gradually extended until the patient attends once yearly as a precautionary measure.

Difficulties and Complications. In some cases it will be found impossible to pass even a fine probe through the canal of the stricture, and this will necessitate opening the urethra proximal to the stricture by a backward extension of the original incision. As has been mentioned, this part of the canal is usually considerably dilated, and on opening it the proximal face of the stricture is reached. A probe or probe-pointed director is passed through its canal distally.

(c) *Suprapubic Cystotomy.* This is the preliminary operation of choice in the presence of the conditions described on page 3082, which contra-indicate all forms of instrumentation. In some cases it has to be carried out as an emergency for such conditions as retention, renal failure, peri-urethral suppuration or extravasation, when preliminary preparation of the patient is impossible. When performed deliberately

the preparation is similar to a cystotomy carried out for other conditions.

Anæsthesia. Gas and oxygen should be employed unless the patient's condition is grave, when local anæsthesia is to be preferred.

Operation. It is usually impossible to wash out and distend the bladder as even a small catheter cannot be passed.

The bladder is opened in the usual way and its cavity explored with the forefinger. Stones are removed, the condition of the prostate is determined, and a search is made for the opening of a possible diverticulum. As a rule no further operative procedure is justifiable, especially if an emergency cystotomy has been performed. Occasionally retrograde catheterisation may be attempted, though this is best deferred to a later date, when the general condition of the patient has improved.

After allowing the viscus to sink back into the pelvis and placing a small tube in the prevesical space, the wound is closed with drainage of the bladder round a Winsbury-White right-angled suprapubic tube.

After-Treatment. This is described on page 2981.

Results of Suprapubic Drainage. (1) Effect on the kidneys. Suprapubic drainage of the distended bladder is not without risk, for hæmaturia and often anuria may occur through the sudden relief of hypertension. The risk, however, is one which must be taken, as otherwise the patient would die. In other cases, especially if treatment calculated to encourage renal secretion is carried out, the results are astonishing; symptoms of renal failure disappear and the patient's general health improves, as shown by his well-being, improved appetite, increased sleep, and diminished thirst.

(2) Effect on the bladder. Cystitis is relieved, especially if complications such as vesical calculi have been removed, and the loss of distressing bladder symptoms such as pain and frequency add much to the patient's comfort.

(3) Effect on the urethra. After a few days, urethral congestion, especially in the region of the stricture, diminishes, and at the end of a fortnight or three weeks it is usually possible to pass a guide or small bougie, even when this has been impossible before operation.

(4) Effect on peri-urethral suppuration and extravasation. By the diminution of congestion and the diversion of the urinary stream,

foci of peri-urethral suppuration and urinary fistulæ will often clear up and eventually heal. Extravasation is checked, and if free incisions have been made into the infected tissues before extensive sloughing has occurred, the patient *may* recover.

Treatment of a Stricture following Suprapubic Cystotomy. After suprapubic cystotomy the stricture is dealt with by one of the following methods: (1) Instrumental dilatation by guides and followers, bougies, metal sounds, and finally by Kollmann's dilator until a cure is obtained. (2) Retrograde catheterisation. (3) Excision.

(1) *Instrumental.* In the majority of cases diminution of congestion allows the successful passage of a guide or even of a small bougie, which is followed up by intermittent dilatations until a cure is obtained, as has been described. A temporary suprapubic apparatus is fitted until a urethral calibre of over 20° French has been attained, when the fistula is allowed to heal, after denuding its track of any ingrowth of epithelium with either pure carbolic acid or a diathermy terminal. In certain cases where dilatation of the stricture is slow owing to much fibrosis or peri-urethral suppuration, a solid suprapubic plug *may* be inserted and the patient allowed to micturate naturally. If retention occurs after treatment, the plug is removed, thus affording relief.

(2) *Retrograde Catheterisation.* In a few cases it is found that the post-operative passage of a guide is not successful, when resort must be made to the retrograde method, i.e. the passage of a guide from the bladder through the internal urinary meatus. Longitudinal sections through post-mortem specimens of stricture usually show that the proximal face is smooth and funnel-shaped, leading to the canal of the stricture, but that on the distal aspect its face is irregular, often distorted, and the opening very difficult to identify. It follows, therefore, that the passage of a guide through a stricture is much easier when attempted from the proximal side. A retrograde guide is constructed on the principle of a follower in that it bears a terminal screw which engages with the hollow mount of the ordinary guide. The retrograde guide is passed through the channel of a Winsbury-White irrigating operating cystoscope and an ordinary guide screwed into it. The cystoscope is passed through the suprapubic sinus, which is rendered more or less watertight by sliding a thick piece of rubber tubing over the shaft of the instrument. The bladder is washed out and distended through the sheath, the telescope is inserted, and the

retrograde guide passed into the internal meatus which is clearly visible. No difficulty in its passage through the prostatic and membranous urethra is, as a rule, encountered but it is finally obstructed at the proximal face of the stricture. By gentle movements of introduction and withdrawal combined with rotation it is often possible to negotiate the canal, as evidenced by a sudden lack of resistance and the appearance of the retrograde guide at the external urinary meatus. The whole of the retrograde guide is withdrawn from the meatus, thereby pulling the ordinary guide with it and rendering the union visible. The former is unscrewed, a follower substituted, and the cystoscope removed from the bladder.

The treatment is concluded by the passage of three gum elastic followers of increasing sizes, or, in the event of dense stricture causing bending of the followers, by curved steel followers, as has been described.

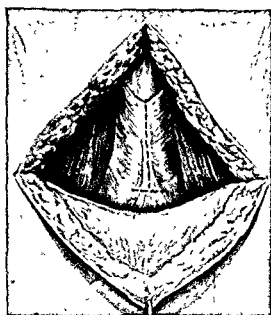
After-treatment consists of intermittent dilatation by bougies and Kollmann's dilator until a cure is obtained.

(3) *Excision.* Excision of a stricture is suitable for small single strictures of either inflammatory or traumatic origin. The operation consists of excising that portion of the urethra containing the stricture, and uniting the divided ends of the urethra over a sound which is then removed with free drainage of the perineal wound. Before this is undertaken, however, the exact state of affairs must be ascertained by a combination of cystogram and urethrogram, the bladder and anterior urethra being filled with 5 per cent sodium iodide and X-rays taken from the lateral aspect. Excision is impracticable if much more than one inch of urethra is involved, or if multiple strictures are present.

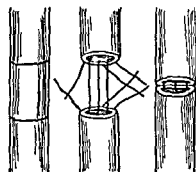
Operation. Suprapubic cystotomy having been carried out at least fourteen days beforehand, the patient is given a general anæsthetic, placed in the lithotomy position, and the suprapubic region and external genitals are thoroughly painted with 3 per cent picric acid in spirit. The bladder is washed out from above and the urethra from below. A curved metal retrograde sound is passed from the bladder through the posterior urethra and held in position by an assistant. By means of an inverted Y incision the perineum is freely opened and after dividing the central perineal tendon to spare the recto-urethralis, the bulbo-cavernosus tendon is incised (fig. A, 1769), whereby the corpus spongiosum surrounding the urethra in front of the stricture is exposed. This part of the urethra is carefully defined and opened on a Wheel-

house's staff. In the majority of cases there is no need to cut the posterior group of perineal muscles. The stricture invariably lies a little way in front of the triangular ligament, and it can be excised from before backwards as far as the retrograde sound, which bulges forwards when pressure is made upon it by the assistant (fig. B, 1769).

The distal portion of the urethra is next mobilised, after which its superior wall is stitched to the corresponding wall of the membranous urethra without mobilising the latter at all (fig. C and D, 1769). The stitches are of fine catgut and should include a good bite of the tissues outside the urethra. The retrograde sound and Wheelhouse's staff



A.



B.

C.

D.

Fig. 1769.—EXCISION OF STRICTURE. A. SKIN FLAP RESECTED, INCISION IN BULBO CAVERNOSUS INDICATED BY DOTTED LINE. B. LINE OF EXCISION. C. SUTURES INSERTED. D. SUTURES TIED.

are removed and a curved metal bougie is passed through the urethra from the external urinary meatus into the bladder. The lateral walls and floor of the urethra are left unsutured, but the perineal muscles are stitched together over it. The bougie is removed and the superficial tissues are partially stitched together around a gauze pack.

After-Treatment. The bladder is washed out twice daily through the suprapubic tube. After ten days a moderate-sized metal bougie is gently passed into the bladder. At the end of a fortnight the suprapubic tube is removed and normal micturition is usually established a few days later, though occasionally a perineal leak persists for a short time. Both suprapubic and perineal wounds should be soundly healed

by the end of three or four weeks. Intermittent dilatation should be carried out, at first by metal sounds and later by Kollmann's dilator, but it is surprising how little tendency there is to subsequent stricture formation after complete excision.

PERI-URETHRAL ABSCESS

Peri-urethral abscess may result from acute or chronic infection of the urethra by extension along the ducts of the urethral glands or by thrombosis in the corpus spongiosum. A stricture is usually present. The condition may arise after instrumentation, especially when a rigid indwelling catheter has been tied in for some time, or may complicate an impacted calculus or foreign body. An abscess may develop in either the penile or bulbous urethra and give rise to a tender swelling on the under-surface of the penis. It may burst into the urethra in its early stages or on to the skin with development of a urethral fistula, or may spread subcutaneously and form a rapidly increasing swelling accompanied by fever, pain, and marked local tenderness.

Treatment. An attempt should be made to rupture the abscess into the urethra by dilatation with either a bougie or Kollmann's dilator. If this is not successful and a urethroscopic tube can be passed, it should be incised by means of a fine insulated wire electrode activated by the diathermy cutting current.

A perineal peri-urethral abscess is opened by a median perineal incision and all loculi are broken down. The cavity is freely drained and lightly packed with gauze soaked in paraffin and flavine. When healing has proceeded for a week or ten days, a stricture, if present, must be dealt with by appropriate methods. Daily baths and dressing of the wound are essential parts of the after-treatment.

FISTULA

Urethral fistulæ may be congenital or acquired. Congenital fistulæ are most commonly seen in one or other of the varieties of hypospadias which have been described on page 3021. Acquired fistulæ may result from inflammation, operation or injury, and very rarely from new growth. A fistula due to inflammation usually results from the external rupture of a peri-urethral abscess. A traumatic fistula may follow an external injury or the surgical opening of a peri-urethral abscess, external urethrotomy for stricture and sometimes perineal prostatec-

tomy. Occasionally a fistula may follow the formation of a false passage by careless instrumentation (fig. 1770), or urethral sloughing after the tying in of a rigid catheter, especially if certain nervous diseases such as paraplegia are present.

Diagnosis. The diagnosis is obvious by observing the escape of urine through an abnormal situation. In addition, the signs and



Fig. 1770.—INCOMPLETE AND COMPLETE FALSE PASSAGES.

symptoms of its causal condition, e.g. urethral stricture, are present. One or more external openings may be noticed if the fistula is situated in the perineum and each is surrounded by much fibrosis.

Treatment. Congenital fistulæ. These have already been described under "Hypospadias."

Acquired Fistulæ. Small fistulæ associated with a urethral stricture will often close spontaneously when the latter has been cured by intermittent dilatation, as has been described. In other cases this result can be obtained after destruction of the lining membrane by a diathermy terminal. If these measures fail and if one or more openings are present, surrounded by much fibrosis, suprapubic cystotomy must first be carried out. A fortnight later the fistula or fistulæ, together with all surrounding fibrous tissue, are freely cut out through an inverted Y incision in the perineum. No regard need be paid to the superficial tissues, but care must be taken not to cut the compressor urethræ muscle. The perineal muscles are then defined as clearly as possible, a stricture, if present, being excised by Kidd's method. The final steps of the operation and after-treatment are also identical with this operation.

NEW GROWTHS

New growths of the urethra are exceedingly rare, but both innocent and malignant varieties have been encountered. Innocent growths include papillomata, fibromata and caruncles. Malignant growths comprise carcinomata and sarcomata.

(1) *Innocent Growths.* *Papillomata* occur either in the penile or in the prostatic urethra, where they arise from the verumontanum. They are, as a rule, associated with chronic urethritis.

Symptoms and Signs. Those of chronic urethritis, with the addition of hæmorrhage which usually occurs at the beginning of micturition.

Diagnosis. This is made by the anterior or posterior urethroscope.

Treatment. Papillomata of the anterior urethra are removed by a diathermy terminal introduced through an anterior urethroscope. Papillomata arising from the verumontanum are destroyed in a similar way, but through a posterior urethroscope.

Caruncle. This innocent tumour invariably occurs in the female urethra, and in most cases is associated with some degree of chronic urethritis. It is characterised by localised pain at the external urinary meatus which is aggravated by micturition. Hæmorrhage sometimes occurs.

The *diagnosis* is obvious, a small, red, fleshy tumour being seen to arise from the floor of the urethra near the external urinary meatus.

Treatment. A urethral caruncle is most effectively excised by the diathermy cutting current, and preferably under general anaesthesia. Recurrence is unfortunately common. The associated chronic urethritis must be cured by intermittent dilatation.

Cysts. Urethral cysts arise from blocking of the mouth of one of Littre's follicles or of Cowper's gland.

In some cases spontaneous rupture occurs into the urethra, but in others the cyst wall should be slit open by means of a wire electrode activated by the diathermy cutting current, and applied through an anterior urethroscope.

(2) *Malignant Growths of the Male Urethra.* In the majority of cases a malignant urethral growth consists of a squamous epithelioma,

the commonest site being the bulbous urethra. In over half the cases it is preceded by chronic urethritis and stricture, and occurs in patients over 45 years. Invasion occurs of the mucous membrane and corpus spongiosum and eventually of the skin, with the formation of fistulæ.

Symptoms and Signs. Symptoms of chronic urethritis or stricture are, as a rule, present, as shown by mild urinary infection and diminished size of stream. In some cases a purulent or blood-stained discharge is present. In early cases bleeding often follows instrumentation, and urethroscopic examination may reveal the tumour if the tube can be passed through the stricture. In later cases induration will be felt in the region of the bulb and a swelling may be seen in the perineum, with reddening of the overlying skin, through which fungation of the growth may take place at a later date. Glandular involvement is first seen in the groins and metastases occur later in the lungs, liver and bones.

Treatment. The choice of treatment lies between complete removal of the penis or the introduction of radium needles, followed in either case by the application of radium plaques to both groins. Unfortunately diagnosis is usually considerably delayed and the results of treatment are correspondingly poor.

(3) *Malignant Growths of the Female Urethra.* These are, as a rule, squamous-celled carcinomata. The symptoms are similar to those of a caruncle, but more severe.

The *diagnosis* is made by the appearance of the tumour and by microscopy.

Treatment. Excision is rarely practicable, but the introduction of radium needles sometimes gives good results.

Tuberculosis of the Urethra. Urethral tuberculosis is exceedingly rare, but may occur as an extension of urinary or genital tuberculosis. The posterior urethra is the commonest site, and may show shallow areas of ulceration, tuberculous granulation tissue, or be involved by the rupture of a tuberculous prostatic abscess. Only very rarely are minute tuberculous ulcers found in the anterior urethra, when stricture and peri-urethral suppuration may result, with the occasional formation of a fistula.

Symptoms and Signs. Symptoms of the causal condition are present, such as frequency, difficulty, and hæmaturia. In addition, a pale, thin, urethral discharge is noticed, and some peri-urethral thickening may be felt.

Treatment. The primary focus must be treated, as has been described under renal and prostatic tuberculosis. In rare cases a tuberculous stricture must be dilated, peri-urethral abscesses opened, and fistulæ scraped and injected with bismuth-iodoform-paraffin paste. A course of tuberculin should be given a trial.

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PART XII

SYMPATHETIC NERVOUS SYSTEM

by
A. LAWRENCE ABEL

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SYMPATHETIC NERVOUS SYSTEM

"It is asked why the involuntary parts have nerves at all; the answer may be given that it is not for their common actions, but to keep up the connection between the whole, for without them an animal would become two distinct machines, and one might be acting very contradictorily to the other; but by the voluntary and involuntary, and also between these last and the mind, an universal and uniform agreement or regulation is kept up, which communication produces one kind of sympathy."

JOHN HUNTER, 1776.

HISTORY

It is just over 200 years (1732) since the Danish anatomist Winslow gave the name "sympathetic" to that portion of the nervous system which is herein described. Prior to that date knowledge of the subject was very inexact, mainly owing to the erroneous views on physiology which were then held. In 1776 John Hunter, in spite of imperfect anatomical data, advanced a theory the main theme of which has not been appreciably shaken by the accumulated work of the numerous investigators who have succeeded him. Apart from this basic work, however, the modern conception of the involuntary nervous system is largely founded on the precise experimental work of Gaskell in 1896 and of Langley in 1898. More recently, many workers have elaborated further details of the subject and have correlated existing knowledge with clinical conditions.

In the present decade it has been realised that dysfunction of the sympathetic nervous system may result in definite clinical and pathological conditions, e.g. Raynaud's disease and Hirschsprung's disease, and that extirpation of the affected tracts will often lead to a cure. Since the study of the subject passed from the physiological laboratory to the domain of surgery more advance has been made in ten years than ever before. The anatomy and physiology of the system are receiving more detailed attention. Lesions produced by derangement of the sympathetic nervous system have been defined and appropriate methods devised for their investigation. Definite indications for surgical intervention have been laid down, while

operative technique is rapidly becoming standardised and prognostication already approaches scientific accuracy.

Thus the general principles of the subject are well grounded, and although much still remains to be discovered, surgery can now offer an increasing degree of cure or relief for sympathetic nervous diseases.

DEFINITION

In general terms the involuntary or autonomic nervous system may be defined as a collection of nervous tissue elements, comprising those parts of the nervous system which are concerned with the innervation of certain glands, the heart, and of unstriated muscle throughout the whole body. In the past, the term "sympathetic" was loosely applied to all that section of the nervous system which is not under the direct control of the will. It is now known, however, that the sympathetic is only a part of the involuntary nervous system, which also includes the "parasympathetic" system (Langley), the latter term embracing a cranial and a sacral division. It must further be emphasised that the word "autonomic" does not imply that it is independent of the central nervous system. In point of fact, part of the system is located in the brain itself, and, as will be described later, the smooth working of its widely separated components is only made possible by efficient central co-ordination.

CHAPTER I

GENERAL ANATOMY

THE nerve supply to the body is shown diagrammatically in figure 1771. On the right is the segmental distribution of the somatic nerves which carry :

- (1) Motor impulses to the voluntary striped musculature of the body, and
- (2) Cutaneous, tendon, and joint sensations from the periphery to the central nervous system.

On the left is the autonomic nervous system, and this is composed of three distinct nerve groups :

- I. A group arising from the brain stem.
- II. A group arising from the first thoracic to the second lumbar region of the cord (occasionally first or third lumbar).
- III. A group arising usually from the second, third and fourth sacral segments of the cord.

The Parasympathetic System. Groups I and III together form the parasympathetic portion of the autonomic system, and are known as the cranio-bulbar and sacral outflows respectively.

The Sympathetic Nervous System. Group II. All the sympathetic nerves arise from the spinal cord from the first thoracic to the first (or second or third) lumbar segments, and from this region are distributed to the whole body.

The arrangement of the fibres concerned is easily followed from the analogy

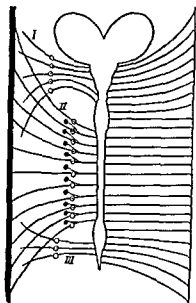


Fig. 1771.—DIAGRAM SHOWING NERVE SUPPLY TO THE BODY; SOMATIC NERVOUS SYSTEM ON THE RIGHT, AUTONOMIC NERVOUS SYSTEM ON THE LEFT.

Groups I and III—Parasympathetic.
Group II—Sympathetic.

of a simple reflex spinal arc (fig. 1772). In the somatic spinal arc, sensory impulses from the periphery are conveyed to the central nervous system by means of an afferent or "receptor" neurone (the term "neurone" including the nerve cell with its related processes, dendrites, and axon). The nerve cell is situated in a posterior root ganglion; the distal end of its axon arises in skin, tendon, or joint, travels in an afferent direction towards the central nervous system, and its proximal dendrites terminate in the posterior horn of grey matter. In this area arises a second neurone, the cell of which is surrounded by the dendrites of the former, and the axon runs towards the anterior horn of grey matter. This is known as the "connector," or intercalated neurone.

In the anterior horn its dendrites arborize round the cells of a third neurone, the lower motor, or "excitor" neurone. Efferent impulses passing along the excitor neurone control the voluntary musculature of the body.

THE SYMPATHETIC ARC

The nervous elements of the involuntary system are exactly comparable to those of the somatic system. The afferent neurones arise in the walls of the viscera and blood-vessels, traverse the sympathetic ganglia without interruption, and reach the central nervous system via the white rami communicantes. They then run with the somatic afferent fibres forming the posterior roots, and have similar cell stations in the first root ganglion.

Their proximal ends traverse the posterior horn of grey matter to end in the lateral horn, which is present therefore only in the thoracic and first two or three lumbar regions of the cord.

The afferent side of the sympathetic system has been the subject of study by Leriche, Heinbecker, Spiegel and others. In support of afferent paths arising and/or running in peri-arterial plexuses, Leriche advances the following points:

- (1) Unilateral peri-arterial sympathectomy may affect both sides of the body.
- (2) Deep sensation is retained after section of all cerebro-spinal fibres.
- (3) Sympathectomy is successful in some painful syndromes;
e.g. Peri-arterial sympathectomy may relieve causalgia.
Stellectomy may relieve trigeminal neuralgia.
- (4) Experimental injection of 50 per cent lactic acid into the wall of an artery produces acute pain which persists after section of all sensory nerves, but which is relieved completely by peri-arterial sympathectomy.

SYMPATHETIC NERVOUS SYSTEM

Heinbecker believes that the large myelinated fibres in the sympathetic nerves rapid conduction rate, are the afferents, while the thinner non-myelinated with slower rate of conduction are the efferents.

Spiegel demonstrated that the afferent fibres travel via the posterior nerve into the antero-lateral ascending tracts of the spinal cord, and there frequently the mid-line. For this reason unilateral cordotomy cannot be counted on to relieve contralateral visceral pain in the same way that it relieves pain from an extrinsic source.

The treatment of various painful conditions associated with the sympathetic nervous system is dealt with later.

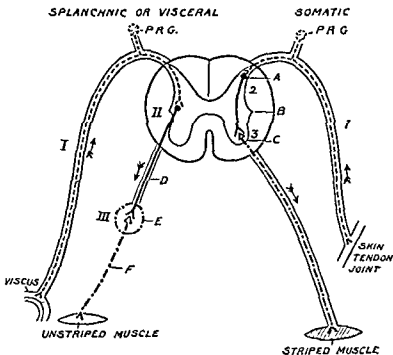


Fig. 1772.—SHOWING SIMPLE REFLEX SPINAL ARC ON RIGHT, SYMPATHETIC ARC ON LEFT.

- | Sympathetic neurones. | Somatic neurones. |
|--|--------------------------|
| I. Afferent or receptor neurone. | 1. Afferent neurone. |
| II. Intercalated or connector neurone. | 2. Intercalated neurone. |
| III. Efferent or excitator neurone. | 3. Lower motor neurone. |
| A. Posterior horn of grey matter. | |
| B. Lateral horn of grey matter. | |
| C. Anterior horn of grey matter. | |
| D. Medullated pre ganglionic white ramus communicans (part of II). | |
| E. Ganglion in sympathetic trunk. | |
| F. Non-medullated post-ganglionic grey ramus communicans. | |
| P.R.G. Posterior root ganglion. | |

The cells of the connector or intercalated neurones are found in the lateral horn, and they give rise to medullated fibres which leave the spinal cord in company with the axons of the anterior horn cells, the two sets of fibres together forming the anterior spinal roots. The sympathetic fibres can be differentiated by their smaller size, being 2-6 μ even less in diameter, compared with the somatic nerves, which are 12 μ . A short distance from their point of exit from the cord, all the

axons arising from cells in the lateral horn leave the anterior spinal roots as white communicating rami to reach the ganglia of the sympathetic trunks. These are the pre-ganglionic white rami communicantes (Langley).

In the ganglion is situated a ganglion cell, the axon of which runs as a non-medullated post-ganglionic grey ramus communicans, thus constituting the third or lower motor neurone. Each grey ramus leaves the sympathetic chain to reach its ultimate goal.

The Pre-Ganglionic Fibres. There are three different terminations of the fibres forming the white rami communicantes :

- (1) By arborising around ganglion cells in the sympathetic chain. Not all, however, end in the first or nearest cell-station in this trunk ; some continue on through several ganglia, and end in a more distant ganglion.
- (2) By passing unaltered through the ganglionated trunk to end around cells in outlying visceral ganglia.
- (3) By continuing unaltered through the ganglionated trunk to the medulla of the suprarenal gland.

The Sympathetic Trunks. The two lateral chains, right and left, consist of ganglia with bundles of nerve fibres between each, and extend from the base of the skull proximally to the coccyx distally, in close relationship to the antero-lateral aspects of the vertebral column.

Post-Ganglionic Fibres. The fibres arising as a fresh relay from the ganglia are known as post-ganglionic. They are non-medullated, are $1\ \mu$ or even less in diameter, and give fibres to each somatic nerve by grey communicating rami.

This post-ganglionic system has a metameric arrangement, but in the case of the pre-ganglionic fibres a segmental-plan is impossible on account of the fact that their origin is restricted roughly to the thoracic region of the cord. The outstanding importance of this lies in the fact that each pre-ganglionic fibre is connected probably with from 3 to 6 peripheral ganglia, and so an efferent impulse travelling along a pre-ganglionic fibre is likely to cause a very diffuse peripheral effect.

The peripheral distribution of these post-ganglionic fibres is in two great streams, one directed cranially and one caudally, being separated at about the level of the tenth thoracic segment. Those passing upwards innervate, from above downwards, the head, face, eye, heart,

lungs and upper extremity. Those passing downwards supply the abdomen, pelvis, lower limbs and perineum. Those to the limbs and abdominal parietes reach their destination with the spinal nerves; those to the viscera remain as individual and identifiable nerves which eventually join company with the main blood-vessels.

MORPHOLOGICAL CONSIDERATIONS

This sequence of innervation follows the order in which these structures arise in the course of development. Similarly, in the trunk, the three main developmental regions have a more or less clearly defined sympathetic nerve supply and physiological functions. (a) Laterally are developed the ribs and parietes of the abdominal wall (somatopleure). The sympathetic fibres to this area travel with the spinal nerves, and their functions are vasomotor, sudomotor, and pilomotor. (b) In the mid-line, the gut and other developmentally mid-line structures (splanchnopleure) receive their sympathetic supply with the main blood-vessels; and here its function is to depress secretion, inhibit peristalsis, give tone to the sphincters, and dilate the bronchioles. (c) The intermediate area (Wolffian ridge) obtains its sympathetic supply from a laterally placed ganglion, the renal ganglion, whence fibres run to supply suprarenal gland, kidney, testis, or ovary. Up to the present time only vasomotor effects have been demonstrated in these fibres.

In other words: (1) the limb fibres arise from the segmental ganglia; (2) the alimentary system receives fibres from the mid-line ganglionated plexuses; and (3) the intermediate organs have their own special intermediate group.

COMPARATIVE ANATOMY AND EMBRYOLOGY

The autonomic system appears comparatively late in the history of the animal kingdom. A vagal system may be demonstrated in the most primitive of the chordates (*Petromyzon*), followed by the appearance of the sacral outflow. The thoraco-lumbar or sympathetic outflow is not manifest till later in the vertebrates; and this order is followed in the embryological development of mammals.

It is an interesting feature that, with the progressive increase in the sympathetic system, there is a corresponding retrogression of the chromaffin system, the latter being much more extensive in the lower

vertebrates. In man this reduction is still proceeding, as is evidenced by the disappearance in the first few years of life of the para-aortic bodies of Zuckerkandl. Such accessory chromaffin tissue, together with the adrenal medulla, arises jointly with the sympathetic nervous elements from the proliferation of cells in the neural crest.

REGIONAL ANATOMY

It has already been mentioned that the two main streams of sympathetic nerve impulses travel in the ganglionated sympathetic chain, and that they diverge at about the tenth thoracic segment. Broadly speaking, the upward stream supplies the body above the diaphragm, while the regions below this level receive their sympathetic innervation from the caudally-directed fibres.

I. THE HEAD AND NECK, THE HEART, AND THE UPPER EXTREMITY

All the fibres running to these parts pass upwards in the sympathetic chain through a ganglionated mass which lies in front of the head of the first rib. This mass of nerve tissue is a combination of the first thoracic and the inferior cervical sympathetic ganglia. In the vast majority of cases these two ganglia are not discrete, but form a complex ovoid body, situated in the position indicated near the costo-central articulation, and for it the term "stellate ganglion" is now generally accepted (fig. 1773). The lower pole, running downwards and backwards, almost immediately joins the second thoracic ganglion, which lies in front of the medial extremity of the first intercostal space, and *extends to the upper border of the second rib.*

The whole mass of ganglionic thickening in the course of the sympathetic chain in the region of the anterior aspect of the head of the first rib, extending upwards to the angle between the vertebral and inferior thyroid arteries and the subclavian artery, is included in the modern term of "stellate ganglion."

In an upward direction the sympathetic chain crosses the inferior thyroid artery opposite the sixth cervical vertebra. At or about this level another ganglion is found, the middle cervical ganglion, which may be well marked or inconspicuous. The superior cervical ganglion lies immediately below the skull, posterior to the internal carotid artery.

From the stellate ganglion arise segmental branches to the upper extremity and visceral branches to the eye, ear, brain and larynx.

(a) *Segmental Branches of the Cervical Sympathetic Trunk.*

These are derived from the upper thoracic segments of the lateral horn of the spinal cord. Passing out to the sympathetic trunk as white rami, they proceed cranially, and after relay in various ganglia (see below) are distributed to the whole of the corresponding side of the head and neck and to the upper extremity. From the superior cervical ganglion grey rami pass to the upper four cervical spinal nerves; from the middle ganglion to the fifth and sixth cervical nerves; from the fused inferior cervical and first thoracic ganglion (i.e. the stellate ganglion) to the seventh and eighth cervical and first thoracic nerves. An additional branch to the first dorsal nerve is occasionally supplied from the second thoracic ganglion (Kuntz), and in operating for the relief of vasomotor abnormalities of the upper extremity, this ganglion must be removed in order to be sure that no vasoconstrictor fibres from it to the arm are allowed to remain.

There may be, however, considerable variation in the arrangement of these grey rami. Their course is behind, through, or in front of the prevertebral muscles. All the above-mentioned sympathetic fibres pass through the stellate ganglion, although many relay in higher ganglia.

The structures supplied are the blood-vessels, salivary, mucous, sweat and sebaceous glands, and the erectores pilorum.

(b) *Visceral Branches of the Cervical Sympathetic Trunk.*

As already pointed out, not all the fibres which reach the stellate ganglion form synaptic communications at that place. Some proceed as pre-ganglionic fibres to the middle and superior cervical ganglia. Those to the eye traverse the stellate ganglion, and not until they reach the superior cervical ganglion do they form synapses with ganglion cells. Axons of these cells travel with the internal carotid artery and so reach the cavernous plexus, whence they supply the extrinsic unstriated muscle of the orbit (Muller's muscle) and the dilator fibres of the pupil. Their interruption, whether pre- or post-ganglionic, results in the well-known phenomena of Horner's Syndrome (see page 3144).

The sympathetic supply to the heart is derived in part from those fibres relayed in the stellate and middle cervical ganglia (possibly also in the superior cervical ganglion). These fibres pass down the neck and into the thorax as the "Cardiac Branches of the Sympathetic" and cross the anterior aspect of the aortic arch to reach the heart.

Additional fibres enter the heart from the thoracic ganglia (see below).

II. THORAX AND ABDOMEN

A. *In the Thorax.*

The sympathetic chain lies behind the parietal pleura and in front of the necks of the ribs and intercostal vessels and nerves. There are twelve typical ganglia, usually fused into ten, and from this long chain arise somatic and visceral branches.

- (1) Segmental branches go to each intercostal nerve, to supply the thoracic and abdominal walls (T. 1-12).
- (2) Visceral branches extend to the pulmonary plexus, to the cardiac plexus, to the thoracic aorta, and to the abdominal viscera.
 - (a) The pulmonary branches arise from the sympathetic trunk opposite the second, third and fourth ganglia and join the posterior pulmonary plexus.
 - (b) Cardiac branches arise from the upper four (occasionally five or six) thoracic ganglia and pass to the heart across the mediastinum.
 - (c) Aortic branches arise from the upper five thoracic ganglia.
 - (d) The branches of supply to the abdominal viscera constitute the three thoracic splanchnic nerves (these are, of course, pre-ganglionic fibres):
 - (i) The greater splanchnic, from thoracic ganglia 5-9.
 - (ii) The lesser splanchnic, from thoracic ganglia 10-11.

Both these nerves pierce the crura of the diaphragm and terminate in the coeliac ganglion. During the thoracic course of the greater splanchnic nerve, the splanchnic ganglion is found upon it, and this is a more prominent structure in the foetus than in the adult. From both nerve and ganglion, thoracic branches arise to supply the oesophagus and descending thoracic aorta.

- (iii) The lowest splanchnic, from the lowest thoracic ganglion (T. 12).

This nerve, after traversing the crura of the diaphragm, joins the plexus on the renal artery.

B. In the Abdomen Proper.

Entering the abdomen behind the medial lumbo-costal arch, the sympathetic chain lies on the antero-lateral aspects of the lumbar vertebræ, in front of the lumbar vessels, and descends along the medial border of the psoas muscle. On the right side it is covered anteriorly by the inferior vena cava, and on the left side it is behind and to the left of the aorta. Medially-directed pre-ganglionic fibres arise from the upper two or three lumbar ganglia, of which there are usually four, and these fibres pass to the intermesenteric, aortic and inferior mesenteric plexuses. These are the lumbar splanchnic nerves, and on the right side they pass behind the inferior vena cava.

Branches of the abdominal portion of the sympathetic are again of two distinct types :

(1) Segmental (parietal).

Grey rami pass from the lumbar ganglia to the lumbar spinal nerves for distribution to blood-vessels, sweat glands, etc., of the parietes.

(2) Visceral.

This is in two groups, upper and lower. The pre-ganglionic fibres supplying them are derived mainly from the three thoracic splanchnics and to a lesser extent from the lumbar splanchnic nerves (two to four in number).

Upper Group. On each side, lying on the crura of the diaphragm medial to the lower pole of the suprarenal gland, is the large irregularly-shaped celiac ganglion. It receives the terminations of the greater and lesser splanchnic nerves on its deep surface (T. 5-11). The two ganglia are connected by numerous fibres embracing the origin of the celiac artery, thus forming a dense plexiform arrangement of fibres which is continued along the branches of the artery. This celiac plexus is joined by branches from the right vagus nerve. From its ganglion cells arise fibres which accompany the renal, middle suprarenal, superior mesenteric, and internal spermatic or ovarian arteries, to constitute sympathetic plexuses of the same names respectively. It also furnishes the sympathetic nerve supply to the cardiac sphincter by fibres which pass along the course of the celiac artery and the left gastric artery.

Lower Group. Many fibres are associated with the aorta itself, but according to Davis, supported by Telford and Stopford, a true aortic

plexus does not exist. They claim that, on each side, running downwards from the coeliac plexus, on the antero-lateral aspects of the abdominal aorta, are one, two, or three bundles of fine fibres, which are termed the intermesenteric nerves. These intercommunicate by two or three slender strands which run across the front of the aorta, but a plexiform arrangement is not present. They are joined laterally by two to four lumbar splanchnics, the upper two of which on each side are destined for the main supply of the distal colon. The latter organ receives no important contribution from the coeliac plexus by way of the intermesenteric nerves.

Below the level of the origin of the inferior mesenteric artery, the intermesenteric nerves are continued down as two trunks, which converge to form the hypogastric plexus, the left trunk passing behind the inferior mesenteric artery or its branches. In addition there is usually an intermediate trunk, which arises from the intermesenteric nerves of each side and communicates directly with the inferior mesenteric plexus.

In describing the sympathetic nervous system mention must be made of the adrenal glands. The adrenal glands are situated on the upper postero-medial aspect of the kidney close to the vertebral column. They are golden in colour, soft, friable, and vascular, and are maintained in position by strands of sympathetic nerves, by fibres from neighbouring fascial planes, and by blood-vessels surrounded by fat.

The right adrenal gland lies in relation to the diaphragm, the vena cava, the liver, the head of the pancreas, the duodenum, the kidney and the vertebral column. The left adrenal gland lies in proximity to the tail of the pancreas, the spleen, the aorta, the diaphragm and the vertebral column. Nerve fibres, about thirty

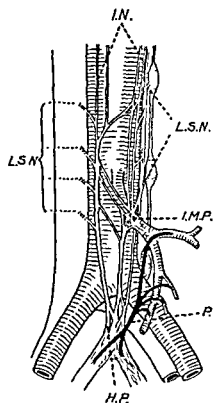


Fig. 1774.—DIAGRAM OF LUMBAR SYMPATHETIC AND PELVIC PARASYMPATHETIC SYSTEMS. (After Telford and Stopford.)

- I.N. Intermesenteric nerves.
- L.S.N. Lumbar splanchnic nerves.
- I.M.P. Inferior mesenteric plexus and ganglion.
- P. Parasympathetic fibres to distal colon and rectum.
- H.P. Hypogastric plexus (superior portion)—i.e. presacral nerve.

in number, run to all parts of the glands except the anterior surface.

In hyperthyroidism the texture and appearance of the glands are changed and adhesions to neighbouring tissue and vascularity are increased. During operations on the glands oozing may be at first excessive, but clotting rapidly takes place.

M manipulation of the glands causes an immediate rise of blood-pressure. No other gland or tissue in the splanchnic area will cause this.

C. In the Pelvis.

The Presacral Nerve. The term "presacral nerve" was applied for the sake of surgical convenience by Latarjet to that part of the sympathetic nervous system which lies in front of the 4th and 5th lumbar vertebrae. Thus its position is really pre-lumbar, lying between the diverging common iliac arteries. The hypogastric plexus is divisible into the superior, middle, and inferior (bilateral) plexuses; and it is the superior portion thereof which is meant by the term "presacral nerve."

The "nerve" commences just above the level of the bifurcation of the aorta and extends distally to the promontory of the sacrum. It is about 5 cms. in length, and is enclosed in a tough sheath of condensed areolar tissue, which is readily separable from the surrounding structures. Anteriorly it is in contact with, and may be visible through, the posterior parietal peritoneum; while posteriorly the left common iliac vein above, and the middle sacral artery below, separate it from the anterior aspect of the body of the 5th lumbar vertebra. On its left side is situated the mesosigmoid.

Inferiorly, the hypogastric plexus separates into two divisions, which are continued on as the right and left pelvic plexuses respectively, and ultimately supply sympathetic fibres to all the pelvic viscera.

The sympathetic chain on each side behind the common iliac artery, crosses the sacral promontory, enters the pelvic cavity, where it lies on the sacrum medial to the sacral foramina. The two chains join together in the sacral plexus, though frequently two are coccygeal ganglion. A number of grey rami, to join the sacral and coccygeal

THE DISTAL COLON

The distal part of the large intestine, lying within the vascular bed of the inferior mesenteric artery, receives its sympathetic nerve supply through the inferior mesenteric plexus. This plexus surrounds the origin of the artery, and is constituted by groups of fibres running from the medial sides of the right and left intermesenteric nerves. It has been demonstrated that these fibres are derived chiefly from the upper lumbar ganglia on each side.

As regards the parasympathetic nerve supply, existing knowledge is still rather vague. For instance, it has not yet been proved definitely whether the parasympathetic innervation is derived from the cranial division (*vagi*), or from the sacral division (*pelvic splanchnic nerves*). The former is improbable on various grounds, and Telford and Stopford have recently submitted that most, if not all, of the fibres come from the pelvic splanchnic nerves (S. 3 and 4, and occasionally S. 2).

They claim that the pelvic splanchnics on each side supply fibres which run upwards and converge to form a single parasympathetic trunk on the left side of the hypogastric plexus. This small trunk joins the inferior mesenteric plexus about one to one and a half inches distal to the origin of the artery from the aorta, and thence runs as a *perivascular plexus on the left colic artery to be distributed with its branches*. Near the point where the main trunk of the nerve crosses the left common iliac artery, fibres are given off from its left side to run with the sigmoid and superior hæmorrhoidal arteries to the pelvic colon and rectum. The latter organ, however, probably receives its main parasympathetic supply directly through the pelvic plexuses.

To summarise, the distal colon has a bilateral sympathetic innervation through the inferior mesenteric plexus, derived mainly from the upper lumbar ganglia by way of the upper two lumbar splanchnic nerves. The greater part of its parasympathetic supply is derived from the pelvic splanchnic nerves on each side, by means of a single trunk which ascends on the left side of the hypogastric plexus to join the inferior mesenteric plexus about one to one and a half inches distal to the origin of the artery from the aorta.

THE KIDNEY, URETER AND BLADDER

Kidney. The renal plexus is formed by filaments from the cœliac plexus and from the lowest thoracic splanchnic nerve (from T. 12 segment).

A. *Cranio-Bulbar Outflow.* These fibres arise from nuclei in the brain stem and leave in the 3rd, 7th, 9th, 10th and 11th cranial nerves. For details of the distribution the reader is referred to anatomical works, but the structures are as follows :

- By the 3rd nerve : The ciliary muscle (accommodation), and the sphincter pupillæ. Secreto-motor fibres to the lacrimal gland.
- By the 7th nerve : Motor fibres to the submaxillary and sublingual salivary glands.
- By the 9th nerve : Motor fibres to the parotid gland.
- By the 10th nerve : A very large distribution to the alimentary canal and associated glands down to and including the proximal half of the colon, to all the thoracic viscera and to the renal plexus.

The *cardiac branches* are inhibitory to the heart and are distributed to the atria and the atrio-ventricular bundle.

According to Woollard, the smaller branches of the corresponding arteries are innervated mainly from the vagus, whereas the larger branches, though obtaining a double innervation, receive their chief source of supply from the sympathetic system.

The *pulmonary branches* are motor to the broncho-constrictor muscle.

The *gastric branches* are probably secreto-motor to the glands. Stimulation of the vagus excites gastric peristalsis and inhibits the pyloric sphincter.

On the alimentary canal the parasympathetic fibres are secreto-motor to the glands and motor to the musculature of the gut, stimulating peristalsis and inhibiting the following sphincters : pharyngo-œsophageal, cardiac, pyloric and ileo-colic (and sigmoido-rectal from sacral outflow).

Afferent fibres convey general visceral sensibility from the alimentary canal, heart and lungs to the ganglion nodosum of the vagus.

B. *Sacral Outflow.* These fibres arise from the second, third (and occasionally the fourth) sacral segments of the spinal cord, and emerge from the spinal nerve as the *nervi erigentes*. They supply (1) Motor fibres to the musculature of the distal colon and rectum, and inhibitory fibres to the sigmoido-rectal sphincter (and possibly inhibitory fibres to the internal sphincter of the rectum); (2) Motor fibres to the

bladder musculature (detrusor) and inhibitory fibres to the internal sphincter of the bladder; (3) Motor fibres to the uterine muscle; (4) Erectile tissue of the penis or clitoris with vasodilator fibres; (5) The seminal vesicles, prostatic musculature and ejaculatory ducts.

Afferent fibres from the pelvic viscera traverse the nervi erigentes, their parent cells lying in the ganglia of the posterior nerve roots of the second, third (and possibly fourth) sacral nerves.

CHAPTER II

PHYSIOLOGY

GENERAL PHYSIOLOGY

NERVE impulses travelling along the sympathetic portion of the autonomic nervous system stimulate all smooth muscle throughout the body, but their effects predominate upon :

- (1) the blood-vessels, causing vasoconstriction ;
- (2) the alimentary canal, causing contraction of the sphincters and inhibition of peristalsis ;
- (3) the urinary bladder, causing contraction of the vesical sphincter and inhibition of the detrusor muscle.

Other subsidiary effects are upon various glands, the orbit and eye, the sweat glands, and erectores pilorum muscles, and also upon skeletal muscle.

The parasympathetic may be regarded as having in the main an antagonistic action to that of the sympathetic system.

The simplest way to outline the effects of sympathetic nerve stimulation on the one hand, and parasympathetic stimulation on the other, is to call to mind, and contrast, the diverse effects produced in the body at a time of mortal combat, fear, or worry, and those which prevail under conditions of complete relaxation. In the former, sympathetic stimulation produces the dilated pupil, exophthalmos, and widening of the palpebral fissure, with the object of enlarging the field of vision. All the blood-vessels are constricted ; the heart beats faster and with increased force, and the general blood-pressure rises. Peristalsis is inhibited and the sphincters are firmly contracted. Impulses to the liver cause the store of glycogen to be converted into glucose, which is then available for general metabolism. Contraction of the spleen liberates a further supply of red blood-corpuscles. The activity of the sweat glands is increased, and the hair tends to stand erect on the body. Secretion from the salivary region is of a mucous,

lubricating type, and does not contain digestive ferments. In this manner the mind and body reach their pinnacle of functional efficiency.

On the other hand, under restful conditions, the opposite is the case. The retina is rested by the moderately contracted pupil and normal width of the palpebral fissure. The cutaneous vessels take on a normal tone, and the sweat glands are quiescent. Digestion proceeds undisturbed, digestive enzymes are liberated, and there is an increased and adequate supply of blood to the splanchnic area. The intestinal musculature undergoes its normal peristaltic movements, and there is relaxation of the appropriate sphincters. The acts of micturition, defecation and parturition occur following parasympathetic stimulation.

From the consideration of these features it will be realised that under normal circumstances a happy medium between these extremes must be achieved, and that a fine balance must constantly be maintained in order that the immediate requirements of the body may be subserved. In this respect the connector neurones assume an added importance, for it is through the medium of their cells that supraspinal co-ordination is achieved, though they are apparently capable of independent action.

Supraspinal Control. It is thought that groups of pre-ganglionic fibres with similar functions are under the direct influence of bulbar controlling centres, which are dominated by a higher centre. This consists of masses of nerve cells in the lower part of the diencephalon or interbrain, and under conditions of stress it is capable of activating all the lower centres which in turn control the sympathetic reflex arcs.

VASOCONSTRICTOR MECHANISM

The vasoconstrictor fibres of the arterioles are of immense importance, and normally control the appropriate distribution of blood throughout the body. The blood-vessels of the limbs are supplied by sympathetic fibres which leave the main somatic nerves at various levels, and join the tunica adventitia at intervals throughout the entire length of the vessels. The calibre of the terminal vessels is thought to be controlled by a delicate chemical mechanism, due to liberation in the tissues—as the result of the passage of nervous impulses—of a substance resembling histamine. This “H” substance causes vasoconstriction of the capillaries by direct chemical action, and of the

arterioles by means of a local "axon reflex" in the terminal branches of the nerve fibres.

Nerve Supply of Skeletal Muscle. The voluntary musculature is, of course, under the control of the voluntary nervous system, but it has been demonstrated that these muscles also receive a proportion of post-ganglionic grey fibres from the autonomic system. Of great significance is the fact that a single muscle-fibre may have a dual supply, i.e. by fibres of somatic and sympathetic origin respectively. The precise function of the sympathetic in relation to the skeletal musculature is not known, but there is some evidence that it at least has an important function in controlling muscular fatigue. It has no direct relation to muscle tone, which depends on the integrity of the somatic reflex arcs.

Nerve Supply of Intestinal Musculature. It is generally believed that the segmental movements of the intestine are myogenic in origin, and that peristalsis is controlled by the intrinsic plexuses of Auerbach and Meissner. The extrinsic systems (sympathetic and parasympathetic) in all probability subserve a regulatory function. The exact anatomical relationship between the intrinsic plexuses and the extrinsic systems is, however, not yet clearly defined.

Receptor Fibres and Visceral Sensibility. There is no doubt that nocuous stimuli, which ordinarily cause pain, when applied within limits to the viscera produce no subjective sensations. The adequate stimulus here appears to be that of tension, which causes painful sensations of varying degree, particularly in the case of the hollow viscera.

The characteristic feature of this pain is that it is usually not appreciated in the organ of origin, but is referred to a particular area of the parietes which has a corresponding segmental distribution of sensory fibres. The underlying explanation is not known with certainty, but it is presumed to be due to a process of projection by the cerebral cortex.

Moreover, as a result of these projected impulses, corresponding areas of muscular and glandular tissue may be activated, as evidenced by rigidity of the muscle or by glandular secretion.

It would appear also that the reflex path takes on an enhanced power of conduction, and slight stimuli applied to the painful area of the body now give a magnified result. This hyperalgesia may be superficial or deep, and its extent is not precisely demarcated.

Clinical observations of this nature have been of great value in elucidating the problem of the afferent nerve paths from the viscera. It must be concluded that the visceral nerves, previously described, must also include receptor fibres, and it is believed that afferents and efferents have a corresponding segmental distribution.

Normally, the majority of afferent impulses never reach the realm of consciousness, and the healthy individual is quite unconscious of his small intestine, right colon, kidneys or ureter. One is only conscious of those parts of the body where a reservoir is formed, e.g. the stomach, pelvic colon and rectum, the uterus and bladder; and it is interesting to call to mind that malignant disease is far more common in these visceral reservoirs, of whose distension we are normally aware.

The Localisation of Relay Stations. The precise routes of the fibres of most of the autonomic system have been carefully elaborated by ordinary histological methods, but it is of interest to observe how the various relay stations have been accurately localised. Nicotine has the property of acting on the junction between connector fibres and excitor cells, causing temporary stimulation followed by paralysis. If a ganglion of the autonomic system be painted with the drug, and the afferent fibres stimulated, a negative result will indicate that the fibres have relayed in that particular ganglion. It has thus been shown that the excitor cells of the sympathetic system are usually located in ganglia which lie a considerable distance away from the viscus supplied; whereas in the case of the parasympathetic excitor cells, with certain exceptions, e.g. the otic and Meckel's ganglia, the reverse is the case.

Relation to the Endocrine System. As regards the particular means by which the sympathetic exerts its diverse effects, it is necessary to consider its association with two of the ductless glands:

(a) *The Thyroid.* The thyroid gland is supplied by excitor fibres from the middle cervical ganglion. These fibres activate the gland to secrete thyroxin, which probably exerts a sensitising effect upon the sympathetic nervous system.

(b) *The Adrenal Medulla.* This is made up of masses of cells which stain with chromic acid salts, and are for this reason termed "chromophil." Its innervation is peculiar in that the connector fibres arborise around excitor cells in the medulla itself, there apparently being no third neurone present in this case. This is explained by the fact that the adrenal medulla is developmentally part of the sympathetic nervous

system. Its fibres arrive by way of the splanchnic nerves and it is believed that there is a higher controlling centre in the brain-stem.

The medulla secretes adrenalin, which experimentally produces effects directly comparable to that of sympathetic stimulation, except that the sweat glands are not affected. It acts peripherally on the junctional tissue between the nerve endings and the organ itself supplied.

Adrenalin may be looked upon as a sympatho-mimetic substance, augmenting and prolonging the effects of the sympathetic under conditions of emergency or stress; and it may be that it plays a part in the normal bodily functions as well.

Chemically both thyroxin and adrenalin are derivatives of the amino-acid tyrosine which is found in almost all the proteins of a normal diet.

Chemical Agents Concerned. It has been suggested, moreover, that the sympathetic may achieve its results by liberating an adrenalin-like substance, "sympathin," at the pericellular terminations of the sympathetic nerve fibres in the organ supplied.

As regards the parasympathetic system, the theory has been advanced that a chemical transmitter—acetyl-choline—is liberated locally at the termination of its fibres. Experimentally, at least, the effects of injecting this drug are similar to those of stimulation of parasympathetic nerves.

It is probable, however, that acetyl-choline is destroyed (or rather broken down into the relatively inert choline) as soon as it is formed in the body by means of an enzyme, "esterase." This action may be inhibited by means of prostigmin in very weak solutions, and this fact should be remembered in the clinical use of acetyl-choline.

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CHAPTER III

GENERAL PATHOLOGY

General Principles. For reasons as yet little understood, the stimulating effect of the sympathetic nervous system on smooth muscle throughout the body may pass beyond the normal physiological limits into the field of pathology. The affected muscle passes into a state of over-contraction, and wherever such spasm of unstriated muscle repeatedly occurs an area of local congestion is left, with consequent round-celled lymphocytic infiltration, leading later to fibrosis. It follows, therefore, that in the natural course of disease spasmodic phenomena tend to become organic in type. Spasm of an involuntary muscle does not lead to any hypertrophy, but eventually to a disappearance of the muscle-fibres and their replacement by fibrous tissue.

At the beginning of these phenomena the symptoms tend to be intermittent, for example, in Raynaud's disease; later, the fibrotic changes in the walls and around the vessels lead to permanently non-dilatable, or occluded vessels, with trophic changes, ulcerations, and gangrene. This state of affairs is found comparatively early in cases of thrombo-angietis obliterans, and comparatively late in examples of Raynaud's disease.

The effects of angiospasm depend to a large extent on the anatomical regions involved. Thus in Raynaud's disease the attacks tend to affect the peripheral vessels. But in retinitis pigmentosa definite evidence has been found of constriction of the retinal arterioles; and it has been suggested that some cases of migraine and vertigo are associated similarly with spasm of certain cortical vessels.

As regards the smooth muscle of the alimentary tract, excessive sympathetic nervous impulses produce hypertonus of the sphincteric mechanism along with derangement of the normal peristaltic movements. Thus cardiospasm results from sympathetic dysfunction in the region of the cardiac sphincter, while in the lower abdomen Hirschsprung's disease and some types of chronic constipation are found.

Apart from these chronic lesions, much light has recently been shed

on the subject of general peritonitis, from whatever cause, by consideration of the possible role of the sympathetic in producing the typical "peritonitic syndrome."

Experimental stimulation of the splanchnic nerve gives rise to contraction of the ileo-colic sphincter (Elliott), while the injection of chemical irritants into the ileo-cæcal region in animals has a similar result. From this it may be deduced that general peritoneal irritation of infective origin sets up a major degree of sympathetic excitation. This is shown by spasm of the regional sphincters, together with inhibition or dilatation of the intervening bowel, and it produces functional obstruction with typical vomiting and the non-passage of feces or flatus. That this obstruction is usually functional only, and not organic, is shown by the occurrence of incontinence under spinal anaesthesia or just before death. Vasoconstriction of the glomerular vessels causes diminution in the quantity of urine secreted or even anuria. Pallor is evident in the skin, while hyperactivity of the sweat glands increases the diminution of chlorides in the body and tissue dehydration.

Chronic appendicitis and tuberculous mesenteric glands are often associated with vague dyspeptic symptoms, which reasonably may be presumed to follow the local stimulation of sympathetic nerve endings.

As regards the individual components of the sympathetic nervous system removed surgically, careful histological study fails to reveal any change which could be regarded as specific or directly related to any particular disease. Nevertheless, increasing evidence is accumulating that, in a considerable proportion of cases at least, histological changes which are outside the range of normal variations may be demonstrated, for example, in the ganglion cells. These include infiltration of the interstitial tissue with wandering cells, mainly lymphocytes and mononuclear leucocytes, the presence of free cells within the capsules of many of the ganglion cells, neuronophagia of some of the ganglion cells, diminution of the chromidial substance in the cytoplasm of a large percentage of the ganglion cells, deposition of melanotic pigment in a variable percentage, marked œdema of a small number and, in some cases, hyaline degeneration and vacuolation of ganglion cells. Such changes may possibly interfere with the functional activity of the nervous elements and bear a definite relation to the disease processes.

The ætiological importance of a presacral neuritis has been urged by Cotté, who claimed that he found definite inflammatory changes in

the presacral nerve following its resection for intractable dysmenorrhœa.

Reviewing these observations, it is at once apparent that, apart from gross abnormalities in the organs involved, existing knowledge of the underlying pathology of the sympathetic nervous system is infinitesimal. A theory has been put forward here, which presupposes overaction of the sympathetic side of the autonomic system, and such overaction may be conceivably absolute or merely relative. Certain it is that victims of these disorders of the autonomic system appear to inherit or acquire an almost characteristic temperament; but the fundamental reason for this—be its origin metabolic, endocrine, or otherwise—is at present quite unknown.

CHAPTER IV

CLINICAL CONSIDERATIONS AND CLASSIFICATION

In considering the nerve supply of any given part of the body, not only the somatic, but also the sympathetic supply should be taken into account, and in reference to any particular pathological lesion, both systems of nerves must be remembered. A patient with a headache has a pain in the region supplied by the fifth cranial nerve, but that area also receives sympathetic fibres from the first and second dorsal regions of the cord. Pain in the little finger may denote a lesion of the eighth cervical and first thoracic nerves, but the blood-vessels and sweat glands, etc., in that region are supplied by sympathetic fibres from the mid-dorsal region (T. 5-9) of the cord also, and it may be that this is the tract really at fault. Pain felt in the region of the heel suggests the first and second sacral segments, but the sympathetic supply comes from the tenth thoracic to the second lumbar region.

In addition to these two systems a third, the parasympathetic nervous system, must be borne in mind. It is known from deduction that parasympathetic fibres also supply these situations. In the limbs the action of the sympathetic is much more marked than that of the parasympathetic, the latter being so slight that it seldom comes into our calculations. In the case of the viscera, however, the two portions of the autonomic system are of almost equal potency.

The proper functioning of the autonomic system depends on perfect adjustment of its components, and overaction of its sympathetic portion results in spasm of blood-vessels or of the intestinal musculature. Such overaction of the sympathetic system may be prevented by interruption of the sympathetic arc, thus arresting the passage of abnormal impulses; and there is abundant proof that this can be achieved by surgical measures. In practice it has been found that comparatively large sections of the sympathetic system can be removed without any severe attendant disadvantage. As mentioned in the Pathology section these excised portions may show little or no histological deviations from the normal. This is of no practical importance,

for the surgical objective is reached if the nervous pathway is adequately broken.

It has been shown that the sympathetic fibres in the extremities run with the main somatic nerves of those limbs, leaving them at various levels, to supply vasoconstrictor fibres to the walls of the blood-vessels. Therefore, peri-arterial sympathectomy will only affect the vessel for a short distance, and will not bring about complete vasodilatation of a whole limb. In order to cause complete vasodilatation, and incidentally complete absence of sweating and paralysis of *erectores pilorum*, all the sympathetic fibres to the affected region must be divided. This is only possible by a *central attack*.

Owing to the lack of existing knowledge of the finer anatomical details, sympathectomy may be unnecessarily destructive in achieving the desired results. Thus in order to secure complete sympathetic denervation of the upper limbs, the entire head, the neck, and the heart must be simultaneously deprived of their supply. Possibly in the future further accurate research will furnish more precise methods than a ganglionectomy, which is a comparatively crude proceeding. Unfortunately the finer method of ramisectomy has been followed in some instances by regeneration of nerve fibres, which never occurs after complete ganglionectomy. In addition, the anatomical positions of the rami are so inconstant as to make their complete resection an almost impossible operation.

Effects of Sympathectomy. The possible direct effects of sympathectomy are twofold :

- (1) The removal of tonic impulses to unstriated muscle (either stimulatory or inhibitory); and
- (2) The interruption of afferent impulses.

Indirectly, the severance of vasoconstrictor fibres to the blood-vessels causes an increase in the blood flow to a particular region; and in all probability this is the important and most beneficial result. In this regard it is interesting to note that beneficial results have been achieved in certain paralyses due to anterior poliomyelitis. In this disease there is no evidence of sympathetic dysfunction, and the lower vascularity of the limbs involved is of purely mechanical origin following loss of voluntary movement. These cases are often subject to recurrent chilblains and ulceration, and amelioration of symptoms following sympathectomy is due solely to an enhanced blood supply. In a similar way, a cure may be often effected in various forms

of chronic ulcers and certain types of gangrene, e.g. senile or diabetic.

Angiospasm in any situation can be relieved by an appropriate sympathectomy, and so the surgical treatment of Raynaud's disease, thrombo-angiitis obliterans, retinitis pigmentosa, etc., is now well established.

Work is at present proceeding at several centres on the treatment of essential hypertension. It has been demonstrated that subjects of this disease show abnormal vasomotor reactions following the application of a standard cold stimulus. Such reactions are obliterated or greatly reduced by high spinal anaesthesia, and it is thought that they are due to a hypersensitive vasomotor centre in the medulla. Good results are claimed from bilateral resection of the major and minor splanchnic nerves in cases where there are minimal degrees of organic changes in the vessels.

Presacral neurectomy gives considerable relief in cases of various forms of pelvic pain, e.g. dysmenorrhœa, and this is thought to be due to interruption of the vasomotor fibres. The complete absence of sensory fibres in the presacral nerve has, however, not been proved definitely.

In regard to spasm of the musculature of the alimentary tract there are two regions commonly involved, the lower end of the œsophagus and the distal colon. Cardiospasm, which may accompany duodenal or gastric ulcer, is amenable to celiac sympathectomy, in which operation the sympathetic supply to the cardiac sphincter is dissected away from the celiac axis and the left gastric artery. Megacolon and some types of chronic constipation may be relieved by the surgical destruction of the sympathetic supply to the affected portion of the bowel. There are many indications that diverticulosis develops because of the increased intra-colonic pressure due to spasm of the sphincters of the distal portion of the large intestine. Sympathectomy is now being employed with encouraging results in order to prevent the progress of the disease and to abolish the pain which is often associated with diverticulitis.

It must be remembered that surgical intervention is so far confined to the sympathetic system. For instance, the sacral parasympathetic nerves are intimately concerned with the important functions of micturition, defæcation, etc., and it is therefore essential to preserve their integrity.

Thus, in the case of the triple nerve supply of the bladder, the parasympathetic nerves must not be disturbed. Complete sympathetic

denervation can be secured by resection of the superior hypogastric plexus, i.e. presacral neurectomy. The effects of this operation extend to all the pelvic viscera as well as the bladder, and include the entire ureter. It is followed by diminished tone in the internal sphincter, and an increase in the detrusor effect of the bladder wall; in other words, it allows the unopposed action of the *nervi erigentes*. In spite of this it is known that the action of each system is not "pure," and under certain conditions a reversed action can obtain. Retention of urine due to certain conditions of the central nervous system, e.g. the condition known as "cord-bladder"—following spinal injuries, especially injuries to the conus and in *spina bifida*, and certain nerve diseases—responds favourably to this type of sympathectomy.

The modern treatment of typical general peritonitis depends on a proper appreciation of the influence of the sympathetic in the development of the peritonitic syndrome. Operative interference should be carefully and gently carried out on the most conservative lines. Adequate post-operative treatment involves the therapeutic depression of a multiplicity of sympathetic reflex arcs. Alkaloids of opium are used in the early stage assisted by barbitone derivatives. At a later stage, belladonna and bromides may be used to depress the sympathetic receptor centres in the bowel, thus abolishing hypertonus. The effects of the bromides are, of course, enhanced by the relative deficiency of chlorides in these alkalotic cases. The prevalent use of pituitrin is to be deprecated, as its action is unselective and merely increases the hypertonus of the sphincters. All fluids by mouth should be completely withheld in order to prevent intestinal peristalsis until the acetylcholine content of the bowel wall reaches a level sufficient to transmit parasympathetic (vagal) nerve impulses. This effect may be augmented by the intramuscular administration of acetylcholine in conjunction with prostigmin, a derivative of eserine.

In causalgia the peculiar syndrome is often dramatically overcome by an appropriate sympathectomy, and this form of treatment has now displaced the doubtful expedient of excision of the peripheral nerve involved.

Patients suffering from inoperable carcinoma may be given a certain measure of relief from pain; that this is, as a rule, only of temporary duration is due to extension of the neoplastic process. Incidentally it is now considered good practice to include resection of the presacral nerve and inferior mesenteric ganglion along with the radical cure of cancer of the rectum.

The foregoing is meant to give merely a broad outline of the clinical

applications of present knowledge of the sympathetic nervous system, and in particular those the value of which is already well established. Intensive research is slowly but surely providing a new interpretation of the various manifestations found in an increasingly large number of diseases, and is placing the surgical treatment of the latter upon a more certain basis.

CLASSIFICATION OF CLINICAL CONDITIONS

It is impossible to make an exact classification of disorders of the sympathetic nervous system, in view of the very limited knowledge concerning their ætiology and pathology. Definite abnormalities may be found in the organs involved, but accurate evidence is lacking of gross structural changes in the sympathetic nerves supplying those organs. Moreover, the manifestations of such diseases are not necessarily confined to a particular system of the body, and so precise lines of demarcation cannot be drawn between them. Bearing these points in mind, however, diseases amenable to sympathectomy may be roughly grouped under six headings according to the system that is chiefly affected, as follows :

I. *The Blood-vessels.*

A. Of the Extremities.

- (1) Raynaud's disease.
- (2) Thrombo-angitis obliterans.
- (3) Associated vasomotor neuroses.

(a) Upper Limb :

Acrocyanosis.
Pneumatic hammer disease.
Scleroderma and Sclerodactyly.
Cervical rib.

(b) Lower Limb :

Erythromelalgia.
Erythrocyanosis crurum puellarum frigida.

- (4) Heterogeneous group.
Chronic ulcers.
Gangrene.
Poliomyelitis.

Chronic arthritis.
Traumatic osteoporosis.
Arterial obliterations.
Volkmann's contracture.

B. Of the Head.

(1) The Eye. Retinitis pigmentosa.

(2) The Ear.

Ménière's disease.

Deafness.

Vertigo.

(3) Cerebral lesions.

Epilepsy. (See also Kinetic system.)

Mental deficiency.

Post-encephalitic states.

Cerebral paralyses.

(4) Migraine and Chronic headaches.

C. Of the Thorax.

Angina pectoris.

II. *The Sweat Glands.*

Hyperidrosis.

III. *The Viscera.*

A. The Alimentary Canal :

(1) Œsophagus ; cardiospasm.

(2) Stomach ; peptic ulcer.

(3) Colon ; Hirschsprung's disease.
Chronic constipation.

B. The Urinary Tract :

(1) Kidney.

Renal sympathetico-tonus.

- (2) Bladder.
"Cord-bladder."

C. The Thorax.
Asthma.

IV. *The Afferent Nerve Pathways :*

- A. From the Head.
Neuralgias.
- B. From the Viscera.
Inoperable neoplasms.
- C. From the Extremities.
Causalgia.
Painful amputation stumps.
Painful ulcers.
Pain of gangrene.

V. *Sympathetic Diseases in relation to Gynecology.*

VI. *The Kinetic System.*

- (1) Neuro-circulatory asthenia.
- (2) Essential hypertension.
- (3) Hyperthyroidism.
- (4) Diabetes mellitus.
- (5) Epilepsy.
- (6) Peptic ulcer.

CHAPTER V

SYMPATHETIC DISEASES OF THE BLOOD-VESSELS

RAYNAUD'S DISEASE

Definition. Raynaud's disease is a vascular change produced by abnormal sympathetic nerve impulses without primary organic disease of the vessels. It is seen chiefly in the upper extremities, especially the fingers, but also occurs occasionally in the feet, tips of ears and nose, and in the viscera. It is characterised by an intermittent or persistent ischæmia or a passive hyperæmia, leading to a disturbance of function or to loss of vitality with necrosis of the parts.

Ætiology. It occurs predominantly in women, and in the third decade of life. Attacks may begin much earlier, but it is rare in the aged. Nationality plays no definite part. A constitutionally neurotic disposition, often of an hereditary nature, predisposes to the disease, and several members of the same family may be affected.

Pathology. Attacks of spasm of the peripheral arterioles and venules, commonest in those parts which are most exposed to cold, result in temporary vascular occlusion. This leads to (1) blanching of the skin; (2) numbness from involvement of the cutaneous sensory nerve endings.

When recovery occurs, the skin becomes violet and then red in colour due to "reactive hyperæmia."

Following repeated attacks fibrous changes occur in all the layers of the vessel walls, especially in the intima, eventually leading to small areas of necrosis or even gangrene.

Histology. In Förster's Clinic degenerative changes were seen in Clark's column of the spinal cord in a case of Raynaud's disease. Many authors have reported that there is no constant abnormality in the sympathetic ganglia.

Symptomatology. The symptoms of Raynaud's disease are intermittent attacks of symmetrical vascular disturbances, manifested by

changes in colour, local discomfort with pain or numbness, but with persistence of pulsation in the main arteries in the periods of remission.

Three stages occur :

(1) Local syncope—a dead white anæmia of the digits occurs, coming on in a few moments, and lasting for a few minutes to an hour. The digit is cold, thin, tapering, and has wrinkled skin with numbness and paræsthesia.

(2) Local asphyxia—a mild or marked cyanosis occurs either after or before the pallor. It affects not only the digits, but may extend to hands or feet, or even to forearms and legs, which become cold, moist, clammy and painful. The colour of the affected parts varies considerably and the temperature is markedly lowered. The paroxysm subsides gradually, giving rise to active hyperæmia, the part becoming

TABLE 1

(after Mayo Clinic)

THE INCIDENCE OF RAYNAUD'S DISEASE IN THE SEXES, AVERAGE AGE, DURATION OF DISEASE PREVIOUS TO SYMPATHECTOMY, THE RELATION OF THE INVOLVEMENT TO THE UPPER AND LOWER EXTREMITIES, AND THE NUMBER OF OPERATIONS PERFORMED

Group.	Type of Disease.	Cases.	Age, Years.	Male.	Female.	Average Duration of Symptoms, Months.	Average Duration since Sympathectomy, Months.	Cervicothoracic Sympathectomy.	Lumbar Sympathectomy.
1	Uncomplicated	16	33.6	1	15	58.6	34	11	5
2	With ulcers	6	25.7	0	6	71	40.7	3	3
3	With ulcers or gangrene with scleroderma and arthritis	32	33.0	3	29	70	25.7	25	7
	Totals	54	30.7	4	50	69.5	33.2	39	15

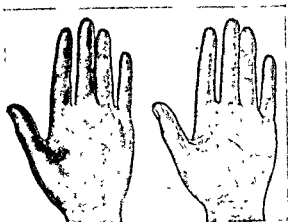


Fig. 1770.—A CASE OF RAYNAUD'S DISEASE SHOWING THE CHANGES IN CIRCULATION OF THE HAND BEFORE AND AFTER CERVICAL GANGLIONECTOMY. (Same case as Fig. 1797.)

blood-red with increased heat and throbbing. If the asphyxia does not subside, there develop :

(3) Symmetrical gangrene and trophic disorders.

Small areas of skin become black and gangrenous, surrounded by an area of ulceration. Separation is slow, and extremely painful.

Complications. Since the symptoms of Raynaud's disease are due to angiospasm, evidence of similar changes may be found in other parts of the body. In the eye, for example, there may be diminution of the visual field due to spasm of the retinal artery. Temporary monoplegia, hemiplegia, and aphasia may occur as a result of cerebral vasospasms. Intermittent hæmoglobinuria and also urticaria have been reported, especially under the influence of severe cold. Marked

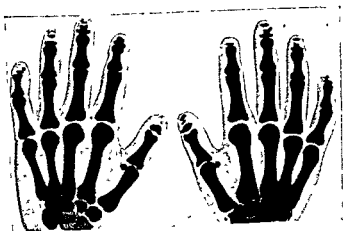


Fig. 1777.—X-RAY OF HANDS IN A CASE OF RAYNAUD'S DISEASE DEPICTING ATROPHIC CHANGES IN THE TERMINAL PHALANGES.

bony atrophy, with disappearance of the tips of one or more of the phalanges, may be demonstrated by X-rays (see fig. 1777). Osteoarthritis of the phalangeal joints and even of the knees may occur. Sclerosis of fascia, or of the skin, may be associated producing sclerodactyly or scleroderma.

Investigation and Treatment. (See Chapters XI and XII.)

TABLE 2
(after Mayo Clinic)

RESULTS FROM CERVICOTHORACIC SYMPATHECTOMY OR LUMBAR GANGLIONECTOMY AND TRUNK RESECTION FOR RAYNAUD'S DISEASE

Group.	Type of Disease.	Case	Average Relief of Colour Changes, Per Cent.	Average Relief of Pain; Per Cent.	Average Healing of Ulcers; Per Cent.	With Recurrent Signs.	With Incomplete Sympathectomy.
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Cervicothoracic Sympathectomy (39 cases)

1	Uncomplicated . . .	11	85	85	No ulcers	None	None
2	With ulcers . . .	3	60	60	100	1	1
3	With ulcers or gangrene with scleroderma and arthritis . . .	25	85	75	85	4	4

Lumbar Sympathectomy (15 cases)

1	Uncomplicated . . .	5	100	100	100	None	None
2	With ulcers . . .	3	100	100	100	None	None
3	With ulcers or gangrene with scleroderma and arthritis . . .	7	90	90	90	None	None

THROMBO-ANGEITIS OBLITERANS

Definition. Buerger's disease, or Thrombo-angeitis obliterans, is a condition involving particularly the deeply situated and larger arteries and veins of the lower and upper extremities with extensive fibrosis, and later occlusive thrombosis. The superficial veins are frequently the seat of migratory thrombotic phlebitis.

Ætiology. The condition is almost always confined to males (at least 95 per cent), and in over 50 per cent of cases to Semitic subjects. It usually occurs between thirty and forty years of age.

A specific cause is unknown; but the occasional remission of symptoms, following the removal of a definite focus of infection, suggests a toxic origin. This may be compared with the exact similarity between the symptoms and pathology of ergot poisoning and those of thrombo-angeitis obliterans.

Theories have been put forward that disorders of both carbohydrate and lecithin metabolism have a bearing on the incidence.

Tobacco has long been suggested as a predisposing factor, but numerous cases are seen in which it has played no part.

Maddock and Collier have shown that "normal" persons, while smoking cigarettes, undergo a peripheral vasoconstriction, as demonstrated by a fall in the skin temperature varying from 2° C. to 6° C., with a return to normal on cessation of smoking.

In view of many points of similarity between thrombo-angeitis obliterans and the later stages of Raynaud's disease, and the fact that interruption of the sympathetic innervation will improve or cure both conditions, it would seem probable that the initial lesion in each case is a vascular spasm due to abnormal vasoconstriction tonus.

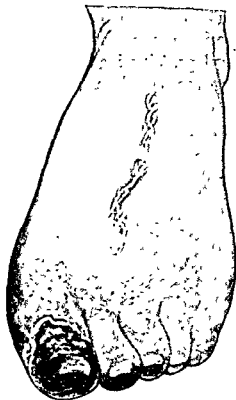


Fig. 1778.—THE FOOT IN A CASE OF THROMBO-ANGEITIS OBLITERANS SHOWING GANGRENE OF THE BIG TOE AND SUPERFICIAL PHLEBITIS.

Pathology. Macroscopically, the vessel walls are thickened, and arteries, veins and nerves are firmly matted together in a fibrous mass. The arteries are often occluded by thrombi, and phlebitis of the superficial and deep veins is common (fig. 1778). Microscopically, there is proliferation of the adventitial connective tissue, and thickening of the intima of the vessel. The thrombus commonly becomes organised, and the degree of recovery depends upon the extent of canalisation or resolution. If the organised thrombosis remains, the vessel becomes a fibrous cord, but owing to the fact that intimal changes tend to be absent in the smaller arteries, a good collateral circulation often develops, following thrombosis of a larger artery. If this is inadequate, large areas of ulceration or gangrene follow.

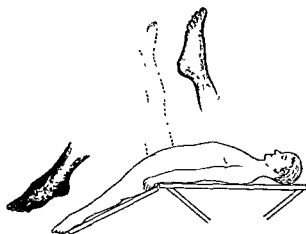


Fig. 1778.—To illustrate the "Angle of Circulatory Efficiency" in THROMBO-ANGITIS OBLITERANS. NOTE THE ARTERIAL CONGESTION WITH DEPENDENCY, AND THE MARKED PALLORED WITH ELEVATION, OF THE FOOT.

Prognosis. The clinical course of thrombo-angitis obliterans varies greatly, but it is usually chronic with periods of remission and relapse. In more than 25 per cent of cases it is found necessary to amputate one or more limbs. Death commonly occurs from intercurrent infections.

Symptomatology. The first symptom is indefinite pain in the sole of the foot or calf, followed by intermittent claudication—cramps, weakness, and paresis of the muscles. The pain is especially noticed on exertion and in cold, damp weather. Shortly after, postural changes in colour make their appearance. The patient notices that the affected foot is more red than the other when hanging down, but on elevating the leg to the horizontal, or even less, the foot quickly becomes blanched.

The greater the angle necessary for blanching to appear, the better is the "angle of circulatory efficiency" (see fig. 1779). Usually at this stage the pulsation in the dorsalis pedis and posterior tibial arteries is definitely diminished or absent. Occasionally the disease remains stationary, but usually the condition steadily progresses and all symptoms become worse. The pain is continuous even at night, and is frequently located around the base of the big toe-nail. In addition, trophic changes, superficial ulcerations, and variable degrees of gangrene eventually supervene.

It sometimes happens that the progress of the disease is arrested, and the condition remains stationary for several months. It may then

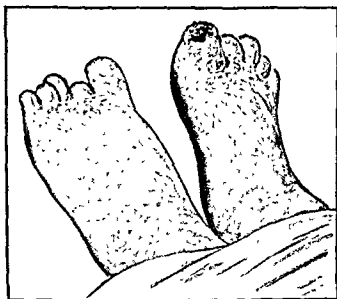


Fig. 1780.—SPONTANEOUS AMPUTATION OF TOES IN A CASE OF THROMBO-ANGITIS OBLITERANS.

improve with dramatic suddenness, probably due to canalisation of the intra-vascular thrombi. In a further group of cases there is an acute onset of symptoms, with rapid progress of the disease through all the stages to massive gangrene in from one to three months (fig. 1780). In the average case the patient is incapacitated by pain, and there are no constitutional symptoms except those which result from loss of sleep and appetite and the intense mental depression which often accompanies this disease.

The lower extremities are affected alone in 60 per cent.

The upper extremities are affected alone in 2 per cent.

The upper and lower extremities are affected together in 38 per cent.

Though the disease often begins unilaterally, it becomes bilateral in 98 per cent of cases, and for this reason Adson and Brown recommend that ganglionectomy should be performed bilaterally as a routine in those cases requiring operative interference.

Differential Diagnosis between Raynaud's Disease and Buerger's Disease.

In the absence of infectious or debilitating diseases the symptoms of each are alone sufficient to differentiate them. Debilitating diseases, for example, syphilis and diabetes, together with any possible septic focus, must be excluded before proceeding to a diagnosis. Raynaud's disease is a disease mainly of women, affecting the upper extremities symmetrically. Buerger's disease is a disease of men (95 per cent) affecting the lower extremities. It begins first on one side, and then both sides become affected. In Raynaud's disease the attacks are precipitated by exposure to cold, or emotional stimuli, and may be relieved by heat. The attacks begin with pallor of the affected fingers and are followed by pain. The colour of the digit is not affected by posture, and the pain disappears with rest. In Buerger's disease the pain on exertion is the first symptom and is accompanied by early fatigue of the muscles and intermittent claudication. It is characteristic of the disease in its later stages that pain persists even at rest—the so-called "rest-pains." Postural changes markedly affect the colour of the limb. In Raynaud's disease pulsation is always present in the main arteries during the relieved period, while in thrombo-angitis obliterans marked diminution or absence of the leg pulses is always demonstrable.

Functional Buerger's Disease.

This is a condition sometimes seen in highly strung neurotic people. On investigation with a spinal anæsthetic the soles of the feet retain their extreme hyperæsthesia, although otherwise anæsthesia is present up to the umbilicus.

The condition is cured, however, by the spinal anæsthetic.

Investigation and Treatment. (See Chapters XI and XII.)

ASSOCIATED VASOMOTOR NEUROSES

A number of vasomotor conditions which are ascribed to abnormality of the vasomotor mechanism occur, but do not fall into the

classical picture of either Raynaud's disease or thrombo-angitis obliterans :

(a) *Upper Limb.*

(1) *Acrocyanosis*. Like Raynaud's disease, this is a condition frequently found in young women and is usually induced by cold. Fingers, hands and forearms are blue and swollen, and chilblains are common. That the condition is due to sympathetic dysfunction is shown by the fact that removal of the stellate ganglion effects a cure.

(2) *Pneumatic hammer disease* is a modified form of Raynaud's disease, which affects one or other hand of labourers using a pneumatic drill. The pain and disability necessitate a change of occupation.

(3) *Scleroderma* and *Sclerodactyly* are often associated with other symptoms of vasomotor dysfunction. A complete interruption of the vasomotor paths in the affected region effects a cure if undertaken in the early stages.

(4) *Cervical ribs* produce a localised form of Raynaud's disease due to pressure on the lower trunk of the brachial plexus, in which run most of the sympathetic fibres to the upper limb. The index finger is most commonly affected, and gangrene may supervene. The treatment, of course, is to remove the rib.

(5) *Crutch pressure* has sometimes an exactly similar effect.

(b) *Lower Limb.*

(1) *Erythromelalgia*. This is similar to the hyperæmic stage of an attack of Raynaud's disease. It occurs, however, most commonly in one foot, is only occasionally bilateral, and rarely affects the hands and face. It is more common in men than women, and comes on in hot weather. The patient experiences a burning pain in the sole of the foot, with heat, redness, and swelling. The pain is extreme, and the surface temperature is higher than over unaffected areas.

(2) *Erythrocyanosis crurum puellarum frigida* is a similar condition occurring in the legs of adolescent women. The blue, swollen backs of the legs and ankles are colder than the feet, which are subject to chilblains.

HETEROGENEOUS GROUP

Acute Anterior Poliomyelitis. This condition frequently results in cold, blue limbs, subject to recurrent ulceration and chilblains. The feeble musculature of the limb results in a more than proportionate

diminution in the calibre of the arteries and in a feeble venous return. Although the sympathetic nerve supply to the limb is intact, as shown by a normal rise in the skin temperature of the leg with increased environmental heat (or a spinal anæsthetic, see fig. 1781), the results of a ganglionectomy in these cases is sometimes very striking.

The operation results in an increased arterial blood supply to the affected limb, and so may relieve the coldness, blueness, chilblains, and recurrent ulceration. Even if the increased vascularity diminishes

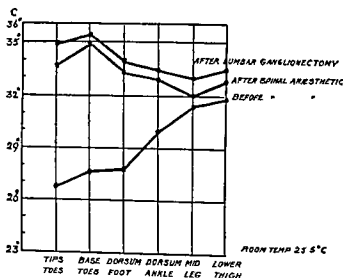


FIG. 1781.—SKIN TEMPERATURE CHARTS FROM A CASE OF POLYMYOSITIS SHOWING NORMAL RESPONSE TO SPINAL ANÆSTHETIC INDICATIVE OF AN INTACT SYMPATHETIC NERVE SUPPLY.

after a few months, on account of the vessels regaining their tone to some degree, the temporary congestion may bring about healing of ulcers and chilblains and occasionally results in a further growth of the limb.

Chronic Arthritis. It has long been known that certain types of chronic arthritis, especially those affecting the small joints and the extremities, have had a nervous or trophic basis in their ætiology. Chronic arthritides of this type, who have failed to improve with ordinary medical and orthopædic treatment, are found to benefit from the improved circulation and the absence of abnormal sympathetic impulses which result from a well-planned sympathectomy. It is essential that the changes should be almost entirely peri-articular, and that no bony changes except atrophy be present. The limb should have definite evidence of an increase of vasomotor tone, as

shown by the response to the increased environmental temperature test or by reaction to foreign protein. The large joints, and those with gross bony changes, are not suitable for sympathectomy.

Traumatic Osteoporosis. This condition is most often seen in the hand or foot following crushing injuries, which result in persistent œdema, cyanosis and coldness of the affected part. The bones become rarefied, the joints arthritic, and a painful, useless extremity results. Many workers have found ganglionectomy the most efficacious method of treatment when combined with the routine electro-therapeutic measures, movements, massage, etc.

Localised Arterial Obliterations. Leriche maintains that the signs and symptoms which appear after the obliteration of a large artery may be divided into two classes :

(1) Those due to mechanical interference with the flow of blood ;

(2) Those resulting from chronic excitation of the nerves in the arterial wall, i.e. vasospasms, cyanosis, pain, and trophic disturbances. In other words, in addition to the mechanical blockage, the obliterated vessel ceases to be an artery, and becomes a diseased sympathetic nerve. Workers have found that resection of the obliterated vessel results in the disappearance of these sympathetic phenomena. Halsted published several cases in 1920, and recently many satisfactory results have been obtained by Leriche.

Animal experiments have shown that the simple ligature of a main artery is followed by considerably more disturbance in the circulation of the limb than in a case where double ligation and resection of the intervening portion of the vessel has been carried out. From what has already been said, the reasons for this are obvious, and bear out the clinical value of resection of the obliterated portion of arteries in human beings.

Volkman's Ischæmic Contracture. This condition is, pathologically speaking, similar to the preceding. The trauma which produces it frequently results in an arterial thrombus, and resection of the obliterated arterial segment is found to result in a cessation of the vasomotor spasms, and to aid in the restoration of muscular movements. The principle, as before, is that the damaged vessel acts as a source of sympathetic irritation, removal of which gives increased blood supply to the damaged muscles and allows repair to take place.

RETINITIS PIGMENTOSA

Definition. Progressive impairment of vision due to a thread-like constriction of the retinal vessels and accompanied by retinal degeneration and the migration of pigment from the choroid to the perivascular lymphatics, leading, if untreated, to ultimate blindness.

The condition is also known as pigmentary degeneration of the retina.

Etiology and Pathology. The vasoconstriction with consequent deficient blood supply produces changes in the retinal cells which lead to a contraction of the fields of vision, and loss of visual acuity. Early night blindness is followed later by total loss of sight.

The degeneration occurs from a zone near the periphery of the retina (area of anastomosis between long and short posterior ciliary vessels) both forwards and backwards, until all the peripheral field of vision is lost and the centre of the retina becomes more and more encroached upon.

Treatment and Results. Severance of the sympathetic fibres to the eye leads to a loss of power of constriction of the arterioles and venules and brings about a marked improvement of the patient's condition.

Royle and others have reported a number of successful and dramatic cases in which this has been accomplished by performing the operation of stlectomy. The results of the operation are :

(1) The production of Horner's Syndrome.

Depression of the tone of the facial musculature on the same side.

Immediate contraction of the pupil, which, however, is not pin-point.

Enophthalmos.

A transient ptosis.

(2) Upon the retinal vessels, etc.

Dilatation of the retinal arteries, arterioles and venules, remaining permanent for several years.

The visual acuity is improved.

The fields of vision are enlarged.

Night blindness disappears.

While no effect was obtained in patients who had been blind for a long time, relief was most marked in younger patients, and they were able to resume their occupations.

Incidentally, in these cases Royle noticed some interesting phenomena, not associated with the eye, but following stellectomy.

One congenital deaf-mute, and one case of acquired deafness, had a contralateral restoration of hearing. This is explained by the fact that the fibres from the cochlea terminate in the temporal convolution of the opposite side; therefore hearing on the right side is restored by increasing the circulation on the left side of the brain and vice versa.

He also found that chronic headaches disappeared in several cases, and in one case vertigo was cured. Although only one side has been operated on in the majority of cases, bilateral improvement occurs, which he explains is due to the accelerated flow of blood in the circle of Willis, which hastens the flow in the longitudinal sinuses and veins, with easier egress on both sides, and so increases contralateral circulation also.

Recently Magitot reports improvements in cases of ocular degenerations following peri-arterial sympathectomy of the common carotid artery. A rise in retinal arterial pressure, accompanied by improved visual function, was obtained in cases of primary optic atrophy, chorio-retinitis, and toxic retro-bulbar neuritis.

It is known, however, that internal carotid sympathectomy is dangerous, and that to ensure total destruction of the vasoconstrictors of the eye the operation of cervico-dorsal ganglionectomy must be carried out, and this is now the accepted treatment for this condition.

Deafness, Ménière's Disease, Vertigo. Rare cases of deafness and vertigo have apparently been cured by operations upon the stellate ganglion. (See above under "Retinitis Pigmentosa.")

It appears worth while pursuing afresh the possibility of curing, or alleviating, idiopathic chronic headaches, migraine, vertigo, etc., by the modern operation of stellectomy. The subject of epilepsy is considered in a later section (see "Kinetic System").

Migraine and Chronic Headaches. It is interesting to note that vasomotor changes have been observed in the retinal vessels during the aura and during an attack of migraine. The retinal artery is at first in a state of vasoconstriction, and this is followed by a stage of vasodilatation.

It is possible that similar vasoconstriction in the cortical vessels

of the brain, and in particular of the occipital region, account for the visual disturbances so characteristic of the early phase of an attack of migraine, while the subsequent engorgement of the vessels, with resulting increase in intracranial tension, may be responsible for the headache and vomiting. Many workers have found that the operation of stelletomy performed for a variety of conditions has frequently led to a disappearance of concomitant chronic headaches and migraine.

Other Cerebral Conditions.

1. Spastic quadriplegia.
2. The post-encephalitic syndrome (Parkinsonism).
3. Congenital mental deficiency.

Royle has had numerous successes in these conditions following cervico-dorsal ganglionectomy, or a section of the thoracic sympathetic chain between the first and second thoracic ganglia. In either case, the operation was carried out bilaterally. He has reported marked improvement, both physically and mentally, with considerable amelioration of all symptoms, presumably as a result of changes in the blood supply to the brain.

CHAPTER VI

ANGINA PECTORIS

ANGINA PECTORIS, when it is not a complication of valvular or advanced myocardial disease, is a surgical illness, because it is an illness that only surgery can cure. There are, in the surgical literature, a sufficiently large number of cases who have remained completely cured for a number of years to make the subject of considerable importance.

In 1906, Jaboulay and Jonnesco operated on the cervical sympathetic ganglia for the relief of angina pectoris, and more than twenty years ago Dr. Charles Mayo removed the superior and middle cervical ganglia in cases of angina, with marked improvement. We know now that these operations were not low enough to include all the sympathetic fibres to the heart, though one of Dr. Mayo's cases has been free of anginal pains for twenty years. Recently the subject has been very thoroughly studied by Leriche and Fontaine, who have now some twenty cases with excellent results.

Ætiology. Angina pectoris is perhaps of special interest to medical men, because it occurs so frequently amongst the educated classes, doctors, lawyers, clergy and the like. In fact, it is a disease of the highly-educated brain worker rather than of other sections of the community. To what peculiar forms of worry, or what special anxieties this class of the community is particularly liable, and why this should affect the coronary vessels, is at present unknown.

Pathology. The condition is looked upon as a vasomotor disease, which produces a vasoconstricting effect upon the coronary arteries, these vessels subsequently passing into a state of spasm. Pain, which clinically is everything, is, pathologically speaking, only an accessory phenomenon. As a result of their experimental work, Leriche and Fontaine have established that the coronary innervation is on the same plan as the general arterial innervation. For example, with a cannula

inserted in the coronary and in the carotid arteries respectively, it is shown that the two react equally and simultaneously to the same nervous stimulation. They have formed the opinion that the nervous (vaso-constricting) phenomena occur first, and are later followed by ischæmia. The cause of death in their experiments was found to be fibrillation of the heart. This fibrillation was not produced, or was produced more rarely, after the stellate ganglion had been removed; hence the possibility of forestalling fibrillation by stellectomy.

Repeated spasms in the coronary arteries lead to degenerative and fibrotic changes similar to those occurring in other vasospastic vessels. These vascular changes are in turn followed by myocardial degeneration. In any acute attack of angina pectoris fibrillation of the heart may occur, with resulting death. White is of opinion that, in addition to fibres which are known to pass through the stellate ganglion, there are also others from the upper four or five thoracic rami communicantes which pass directly to the heart. These, he advises, should be taken into consideration in treatment.

Treatment. Any case which has no great coronary disease and little or no myocardial degeneration, as shown by ordinary clinical and electro-cardiographic methods, is suitable for surgical treatment.

Two definite lines of treatment are available for cases of angina pectoris:

- (1) Operations designed to destroy or remove the vasoconstricting fibres to the coronary vessels:
 - (a) by radical operation;
 - (b) by alcohol injection of the appropriate ganglia.
- (2) Operations upon the thyroid gland (which must, of course, include division of some of the cervical sympathetic fibres to the heart).

(1) (a) *Radical Operation.* Leriche is of opinion that stellectomy is the most satisfactory of all operative procedures for this condition (personal communication). He and Fontaine have performed more than one hundred and fifty stellectomies for different conditions, including angina, without a single operative death. The operation, therefore, is not a serious one. Their operative treatment, in twenty cases of angina, included eleven stellectomies and nine removals of the cervical chain, down to, but not including, the stellate ganglion. The latter procedure was chosen because of difficulties with patients with

short necks, and their results in these cases have apparently been as satisfactory as the stellectomies.

(b) *Paravertebral injections of alcohol.* White, Levy and Moore, and others, have used paravertebral injection of alcohol with marked improvement in 85 per cent of cases of angina pectoris. Not only is the stellate ganglion injected, but also the upper four or five, occasionally even six and seven, thoracic ganglia, in order that any direct fibres, passing across the mediastinum from these ganglia to the heart, may be destroyed. A preliminary novocaine block gives definite indication of the relief which may be expected, and of the ganglia requiring treatment. This is followed by injections of alcohol, as described in the section dealing with the technique of paravertebral injections. It has been found that sympathectomy is indicated in young patients, while in older ones, with a sclerotic cardio-vascular system, injection treatment is the more advisable. Although paravertebral injection of alcohol should effect a more extensive destruction, and certainly saves the patient from a more serious operation, it has the following disadvantages :

Intercostal neuritis is a temporary annoyance in almost every case. Failure to destroy all the required portion of the sympathetic trunk on the first occasion may demand further injection.

(2) *Total thyroidectomy* in the treatment of angina pectoris. It is known that hemi-thyroidectomy gives complete relief from anginal pain on the same side for from two to eight weeks. The pain on the contralateral side is not affected, but ceases at the mid-line. A few weeks after the operation, recurrence of pain on exercise takes place, but removal of the remainder of the thyroid gland gives an appreciable fall in the basal metabolic rate and permanent relief of anginal pain proportional to the diminished work of the heart in the hypothyroidic state. The immediate relief of pain after total thyroidectomy is believed to be due to the interruption of cardiac sympathetic nerve fibres, but this effect is only temporary. Permanent result is due to the reduction of the basal metabolic rate. Many workers now undertake total thyroidectomy as a very satisfactory alternative to procedures directed solely to the sympathetic system.

SYMPATHETIC DISEASES OF THE SWEAT GLANDS

Hyperidrosis. Patients are occasionally seen who are afflicted with very moist, clammy hands, in whom the sweat may actually

drip from the extremities at ordinary room temperatures. This may be their only symptom of vasomotor dysfunction.

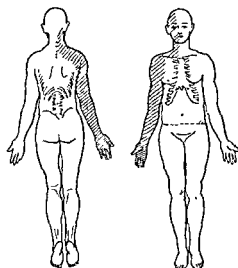


Fig. 1782.—DIAGRAM TO ILLUSTRATE THE AREA OVER WHICH SWEATING IS ABOLISHED BY STELLECTOMY.

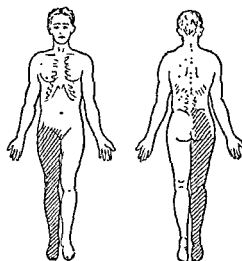


Fig 1783.—DIAGRAM TO ILLUSTRATE THE AREA OVER WHICH SWEATING IS ABOLISHED BY LUMBAR GANGLIONECTOMY.

If ordinary medical treatment (as detailed later) fails to improve the condition, recourse must sometimes be had to sympathectomy, for it is known that removal of the sympathetic nerve supply to the region abolishes sweating completely (see figs. 1782 and 1783).

So infallible is this result that it is a useful index of the extent of operative denervation.

CHAPTER VII

SYMPATHETIC DISEASES OF THE VISCERA

A. *The Alimentary Canal.*

(a) *The Œsophagus. Cardiospasm.* The conditions of hypertrophy, atony and dilatation of the Œsophagus, associated with spasm of the cardiac sphincter, are true neuropathic manifestations. The autonomic centres acting with the vagus in a parasympathetic manner, and via the sympathetic nerves in an opposite manner, control the function of the lower part of the Œsophagus. Predominance of the sympathetic results in a contraction of the cardiac sphincter with inhibition of peristalsis proximal to it, similar to the remainder of the alimentary canal. As we have pointed out elsewhere, the modern theory of cardiospasm is founded upon a great number of Œsophagoscopic and post-mortem examinations, which have shown a dilatation of the Œsophagus with a spasmodic stricture in the region of the sphincter. Spasm of the cardiac sphincter, occurring in a previously normal Œsophagus, is followed by an attempt on the part of the Œsophagus to overcome the obstruction. The wall of the organ therefore hypertrophies, and later dilatation occurs. This leads to stagnation of food, and consequent Œsophagitis, which causes a secondary spasm of the sphincter. Thus a vicious circle is formed, and the early intermittent symptoms eventually become continuous.

Spasm occurring in the region of a sphincter in the alimentary canal leads to a local area of passive congestion, with consequent round-celled infiltration and the formation of fibrous tissue. That fibrosis occurs in the wall of the Œsophagus at the level of the sphincter is well known, and as soon as this cardiac band is established, no further active spasm of the sphincter is necessary in order to maintain the stenosis of the canal.

Similarly the pecten band develops in the anal canal following prolonged spasm of the sphincters.

Treatment. The treatment of the condition, therefore, depends upon the stage in which the patient presents himself, and is of two distinct types.

(1) Treatment of the neuro-muscular disturbance.

(2) Treatment of the organic stenosis.

(1) *The Neuro-muscular Disturbance.* As already pointed out, the cardiac sphincter of the œsophagus receives its sympathetic fibres via the lower thoracic ganglia through the cœliac plexus along the left gastric artery. Peri-arterial sympathectomy of the left gastric artery is known to bring about relief of the spasm in these cases.

One or more of the well-known methods of dilatation should, however, be given a thorough trial before peri-arterial sympathectomy is considered.

Methods of Dilatation. For intermittent dilatation, the mercurial bougies (Hurst) may be used, or gum elastic bougies may be passed, preferably under vision with the œsophagoscope.

For continuous dilatation, a rubber tube may be left *in situ* after introduction, e.g. by the mouth after swallowing a guide.

It must be emphasised that the psychological effect of bouginage upon the patient, in addition to the mechanical effect of this upon the sphincter, is frequently sufficient to inhibit the nervous spasm, and render operation upon the sympathetic nervous system quite unnecessary.

(2) *The Organic Stenosis.* Failing dilatation by bougies other methods must be utilised, such as gastrostomy and digital dilatation from below; plastic operations on the cardiac orifice; some form of anastomosis to circumvent the obstruction, etc.

For further information the reader is referred to the appropriate section of this book.

(b) *The Stomach.*

(c) *The Colon.*

HIRSCHSPRUNG'S DISEASE

History and Definition. Although it was described sixty years before, Hirschsprung, in 1886, drew attention to the condition which

now goes by his name, or the more modern term "Megacolon," and his description: "a condition of congenital high grade dilatation of the colon with thickening of all its tunics, especially the tunica muscularis, with retention of large quantities of faecal matter," still remains accurate.

Ætiology. The disease is primarily one of childhood, but numerous cases occurring in adult life have been reported. It is difficult to decide in these latter cases whether the condition has been latent or whether they come strictly under the category of Hirschsprung's disease. Some authors have grouped these cases as pseudo-megacolon. It is important to exclude cases purely of faecal retention (due to impaction or other causes) which are often reported as curiosities and labelled as Hirschsprung's disease.

The condition has been described in foetuses, and in adults as old as 80 years. 25 per cent of cases occur before the age of 5 years, and 50 per cent of all cases before 20 years. Males are more frequently affected than females in the ratio of 3 to 1. There seems to be a definite familial tendency in some cases.

Pathogenesis. Although a large number of theories have been advanced to account for the condition, the most probable and the one which holds the field at the present time is that the disease is due to a failure of neuro-muscular mechanism. There is an imbalance in the sympathetico-parasympathetic nerve supply of the colon, with an increase in sympathetic control leading to increased tone of the sphincters. The sphincter most commonly affected is at the recto-sigmoid junction (O'Beirne's). But cases have been described where spasm has occurred in other sphincters of the colon, or at the internal sphincter of the anus. That sympathetic overaction is the cause of the condition is confirmed by the fact that appropriate sympathectomy leads to a relief of the condition.

The occasional association of megalo-ureter and/or dilated bladder with this condition further points to a common ætiological factor, namely, their nerve supply.

It has been shown that removal of the parasympathetic rami of the sacral nerves (nervi erigentes) in cats results in the development of megalocolon in some eight weeks. The function of these nerves is to relax the internal sphincter, and it was found that the condition of dilatation of the colon with failure to relax the sphincter was progressive as long as the animals lived. These facts support the neurogenic origin of Hirschsprung's disease.

Pathology. The affected sphincter is tonically contracted and fails to relax. The wall of the colon proximal to the spasmodic stenosis undergoes hypertrophy and dilatation. In 50 per cent of cases only one segment (the sigmoid loop) of the bowel is involved. In others the colon is affected in varying degrees, even to the appendix, which may be as large as a finger. Retention of fæcal matter may be enormous (up to about 47 pounds). The small intestine is never primarily affected.

Symptomatology. The symptoms and signs are simple and definite. Constipation is the leading feature. The child may not have his bowels open for days, weeks, or even months. Aperients have little effect on the condition. Colonic fermentation and decomposition result in occasional attacks of spurious diarrhoea. At intervals there may be attacks of sub-acute intestinal obstruction, with abdominal pain and vomiting. In the early stages the child is outwardly in good health, though later signs of severe auto-intoxication supervene; the skin becomes dry, the facies dull, and the mentality poor. Abdominal distension is usually marked, and although it may be absent at first, in the later stages it may become very severe, leading to embarrassment of both circulation and respiration.

Diagnosis. Diagnosis is best made radiologically. A barium enema should be administered. It is noticed that a very large amount of the radio-opaque substance can be given without causing discomfort, and that this runs into the bowel with ease. The radiograms show enormous dilatation of the affected part of the colon, and no signs of peristalsis or haustration. If radiological examination is preceded by a barium meal, the time of travel through the alimentary canal is normal until the colon is reached, when there is a definite hold-up of the opaque substance.

Investigation. All earlier forms of surgical treatment, e.g. ileo-sigmoidostomy, partial or total colectomy, etc., have been superseded by sympathectomy.

It is important to assess the likelihood of this procedure being of value. This may be done by the test first used by Scott and Morton, which is carried out as follows: The colon is examined radiologically by means of a barium enema, and its size and absence of peristalsis noted. Spinal anaesthesia is then induced as high as the umbilicus (D. 10), and the patient again examined by the fluorescent screen. The

action of the anæsthetic is to cause a temporary paralysis of the inhibitory sympathetic nerves, and leave the intrinsic intestinal plexuses and the vagus unopposed. Thus peristalsis is seen to begin, the colon shrinks in size, and part of the enema is returned. In such a case, sympathectomy is indicated.

The Choice of Operation. Royle, Hunter, Wade and others first performed a ramisectomy of the lumbar rami from L. 2 to L. 5 on the left side only. Later, Judd and others increased this to a lumbar



Fig. 1784.



Fig. 1785.

X-RAYS WITH BARIUM ENEMA BEFORE (Fig. 1784) AND AFTER (Fig. 1785) SYMPATHECTOMY FOR HIRSCHSPRUNG'S DISEASE. NOTE THE REDUCTION IN SIZE OF THE BOWEL AND THE INCREASED HAUSTRATION FOLLOWING OPERATION.

(For these two pictures we are indebted to Mr. M. F. Nicholls.)

ganglionectomy performed on both sides. There is no doubt that these operations were effective, but too radical, as they also removed the sympathetic control of the blood-vessels of the lower limb. The next operation to be employed was removal of the presacral nerve, carrying the dissection upwards as far as the origin of the inferior mesenteric artery from the aorta and including the inferior mesenteric ganglion and its immediate branches. This ganglion is situated on the antero-inferior aspect of the artery shortly below its origin.

This gives complete denervation of the left colon and rectum, and does not damage the vasoconstrictors of the lower limbs. There are, however, three serious objections to it: (1) it causes sterility in the

male by abolishing contraction of the seminal vesicles, ejaculatory ducts, and muscular septa of the prostate gland, i.e. ejaculation fails to occur, and the patient is sterile, though not impotent; (2) it is unnecessarily destructive in that it denervates the rectum, which, in the majority of cases of Hirschsprung's diseases, is unaffected; (3) if the dissection is carried too far in a downward and left lateral direction the parasympathetic supply is in danger of injury (see fig. 1775).

There remain, therefore, two operations which have not these disadvantages: (1) Perivascular inferior mesenteric sympathectomy. This must be carried out around the origin of the inferior mesenteric artery, and must not extend downwards and to the left far enough to damage the parasympathetic nerves. (2) Bilateral division of the lumbar splanchnic nerves (two to four in number) is the operation of choice, according to Telford and Stopford.

The modern operation, therefore, aims at removing the sympathetic nerves to the affected portion of the bowel without damaging the supply to the bladder or lower extremities, and this is most certainly accomplished by bilateral division of the lumbar splanchnics. If this is impractical in any case, a useful alternative is perivascular inferior mesenteric sympathectomy.

Diet, aperients, antispasmodics and enemata should always be tried in milder cases, and are essential adjuvants to surgery in more advanced cases.

As already pointed out in discussing general pathology, the degree of intra-mural fibrosis of the colon increases with the chronicity of the lesion. The potentiality of the gut to contract to its normal size, or the extent of its failure so to do, will have been investigated previously by spinal anæsthetic and X-ray examination. Colonic fibrosis prevents a full restitution of function by sympathectomy, and may demand prolonged post-operative care.

Results of Treatment. Following the operation, the majority of cases are found to defæcate voluntarily and spontaneously. As Flint points out, there appears to be a tendency to relapse in some cases. This may be due to:

- (a) Inadequate removal of all sympathetic fibres.
- (b) Removal of the parasympathetic fibres by too extensive dissection.
- (c) Intra-mural fibrosis owing to chronicity.

It should be prevented as far as possible by more careful attention to operative technique, together with careful selection of cases, and treated by re-education of the bowel musculature by colonic lavage and medical attention.

CHRONIC CONSTIPATION AND DIVERTICULOSIS

Chronic Constipation. The striking results obtained from sympathectomy in megacolon have led many workers to adopt similar treatment for chronic constipation. In view of the slight understanding of the causes of chronic constipation, cases should certainly be given a full course of medical treatment before operation is considered. In addition to the already well-known methods of re-education of the bowels by diet, aperients, exercises, fluids and colonic lavage, it must be emphasised that cases may be benefited by stimulating the parasympathetic, as we have already pointed out.

The specific parasympathetic stimulant is acetyl-choline, and its effect may be augmented by the exhibition of prostigmin. Many cases of sub-acute or chronic constipation have been improved to such an extent by a course of injections of acetyl-choline as to render sympathectomy unnecessary. If all medical treatment fails, the condition of the colon should be investigated by means of X-rays. An opaque meal is administered by mouth and its passage through the alimentary tract observed at 24-hourly intervals until it has all been evacuated. It is, of course, essential that no aperient be given during the investigation. The degree and site of stasis are observed, and also the presence of ballooning or spasms of the colon. Retention of a large proportion of the meal for 7 days is a common finding, and two or three weeks, or even months, by no means uncommon. The most usual site of retention is the pelvic colon, which frequently shows ballooning and lack of haustration.

The degree of improvement likely to follow operation may be gauged by:

- (1) Giving the patient a spinal anæsthetic after the stasis has been observed for a reasonable period, say 7 days, or
- (2) Repeating the examination and giving the spinal anæsthetic when the meal has reached the known site of stasis, usually the second or third day, or
- (3) Administering a barium enema and following this with a spinal anæsthetic as in the investigation of Hirschsprung's disease.

Cases showing a satisfactory response may hopefully be submitted to an operative procedure similar to that advised in cases of Hirschsprung's disease.

Results. Many workers, including ourselves, have obtained dramatic results in many cases of chronic constipation, the bowels being opened without artificial aid within a day or two of operation, where previously they had been confined for many weeks, or only evacuated with large quantities of purgatives or with enemata. It must be stated, however, that some cases do not respond favourably and some of the good results relapse. For discussion *re* this see under Hirschsprung's disease above. With increasing care in investigation prognosis is becoming more certain, and with increasing skill in technique the percentage of cures rises steadily.

Diverticulosis. (See page 950.)

B. *The Urinary Tract.*

(a) *Kidney.* Renal Sympathetico-tonus.

Harris describes a disease syndrome which he names "Renal Sympathetico-tonus."

He defines it as an obstructive nephropathy in which a neuromuscular dysfunction, causing deficient emptying of the renal pelvis, is unilateral and due presumably to over-activity of the sympathetic nerves supplying the kidney. There is a spasm of the ring muscles surrounding the outlets of the minor calyces, major calyces, and the renal pelvis, with resulting distension of the calyces and pelvis.

The association of overwork, worry, and a hyper-excitable sympathetic nervous system is noted. In long-standing cases of this dysfunction the prolonged spasm at the pelvi-ureteral junction may cause a secondary fibrosis in the wall and perhaps organic obstruction there.

The essential symptom is unilateral renal pain, the type varying with the stage of the disease (see below), but in all cases being temporarily relieved by the hypodermic injection of eserine, unless organic obstruction is present.

On clinical examination, the physical signs are :

Tenderness in the costo-vertebral angle during attacks of pain.

Normal findings on urinary examination.

Normal renal function except in the later degrees of Stage III.

These patients are liable to attacks of pyelitis which may result in adhesions and secondary changes, occasionally bringing about organic obstruction to the renal pelvis.

Investigation. (i) *Eserine.* This drug is injected hypodermically in doses of $\frac{1}{100}$ gr. and is of great value in the investigation of this disease, viz. :

(1) It gives temporary relief to the pain of renal sympathetico-tonus.

(2) It enables one to confirm (or otherwise) the diagnosis prior to operation by an injection combined with visualisation in pyeloscopy and pyelography.

(3) At operation it is again useful to confirm the diagnosis.

(ii) *Pyelographic Methods.* Visualisation of pelvic muscular movements is possible by pyeloscopy after ascending or excretion urography.

Serial radiography after a pyelogram gives a good permanent record of the changes in the pelvis.

Ordinary pyelography, if combined with radiological estimate of the emptying time of the renal pelvis, is quite sufficient for routine purposes.

The normal emptying time is about 1 cc. per minute with watery opaque media, e.g. if 10 cc. of fluid are injected into the pelvis, there should be little or no shadow when X-rayed in ten minutes' time.

Any outlining of the pelvis or calyces at this stage is regarded as evidence of retention. The denser the shadow the greater the stasis, i.e. delay in emptying time.

STAGES OF THE DISEASE

I. *Stage of Over-exertion or Hyper-irritability*, where systole predominates and frequent irregular and inefficient contractions of the calyces and pelvis are present, many of which are not transmitted to the ureter. The emptying time of the pelvis is delayed; pain is colicky in nature; hæmaturia may be present. Eserine brings about painless emptying of the pelvis.

II. *Stage of Exhaustion.* Here definite obstruction at the pelvi-ureteral junction is present and diastole of the renal pelvis predominates. Emptying is completely held up as estimated by pyelography. Pain

is a more prolonged dull ache. Eserine gives the same effect as in Stage I.

III. *Stage of Paralysis.* Hydronephrosis of pelvic type has now developed. This is the stage of retention with overflow, and is characterised by attacks of severe renal pain. Eserine gives complete relief of pain unless organic obstruction is also present.

Diagnosis.

(1) Unilateral renal pain relieved temporarily by eserine; after which recurrence takes place.

(2) Pyelographic X-ray evidence of renal stasis involving the pelvis and calyces, again relieved by eserine.

(3) Absence of demonstrable organic cause of the obstruction, except possibly in old-standing cases.

There is occasionally a hypertonic knee jerk on the same side of the body.

Treatment. Renal sympathectomy is the operation of choice and is carried out solely for the relief of pain, and should not be combined with nephropexy or decapsulation.

If the operation is rigidly restricted to the type of case described above, the results show practically a 100 per cent success, while the mortality (at least in Harris's hands) has been nil.

In Stages I and II immediate and permanent relief is afforded by renal sympathectomy alone.

In Stage III the aid of plastic surgery may be required in addition to renal sympathectomy, in order to overcome the secondary organic obstruction.

Operation. The kidney is exposed extra-peritoneally by an adequate lumbar incision and the pedicle isolated as far medially as is reasonably possible. The individual vessels are stripped towards the kidney, and likewise the first inch of the ureter, the uretero-pelvic junction and the pelvis, on both aspects, are denuded of their adventitia (containing the nervous elements). An injection of eserine at the end of the operation is useful to confirm the absence of any obstruction.

After exposing the pelvis and before the denervation, the eserine test is also valuable; following the injection, regular and powerful contractions of the pelvis are seen with complete emptying of same, provided that no organic obstruction is present.

If the pelvis is empty when seen, it may be filled with saline by means of a fine needle in order better to demonstrate the test.

Plastic operations on the pelvis for hydronephrosis should always be combined with a renal sympathectomy.

(b) *Bladder.*

"Cord Bladder." The condition known as "Cord Bladder," which has been mentioned under Clinical Considerations (Chapter IV), may follow pathological lesions of the lower part of the spinal cord.

Retention of urine (often with overflow) occurs from predominance of sympathetic influence. In these cases a presacral neurectomy may bring about considerable improvement by allowing the parasympathetic to act unopposed, i.e. to produce relaxation of the sphincter and contraction of the bladder musculature (detrusor).

C. *The Thorax.*

Asthma. Work is progressing at the present time in many centres on this difficult subject. Variable success has been attained by attacking the sympathetic ganglia in the mid-dorsal region which supply the pulmonary plexuses, either by excision or by injections of alcohol. Some workers combine this with resection of the vagi, but the matter is still *sub judice*.

CHAPTER VIII

THE SYMPATHETIC AFFERENT NERVE PATHWAYS

(1) *From the Head.*

Trigeminal Neuralgia. This distressing complaint is known to be extraordinarily resistant to injection treatment; only 2 per cent of cases following alcohol injection have permanent relief. Semi-permanent relief is obtained with slight risk in the large proportion. Operation, when not contra-indicated by the general condition, and especially by the mental condition of the patient, usually gives a satisfactory result. Numerous cases, however, are on record where section of the sensory root has failed to give relief. These resistant cases especially occur in highly-strung neurotic patients prone to sympathetic diseases. In these cases removal of the cervico-dorsal sympathetic ganglion, or its injection with alcohol, has been followed by dramatic results; although, of course, all workers are familiar with cases which resist all forms of treatment.

(2) *From the Viscera.*

PAIN FROM ADVANCED INOPERABLE NEOPLASIA

To be effective, palliative surgical treatment of this distressing condition must be very extensive. Presacral neurectomy extending upwards as high as the origin of the inferior mesenteric artery is indicated, as well as resection of the lower part of both lumbar sympathetic chains. In Cotté's opinion, any relief gained is usually only transient, owing to further extension of the malignant process.

From our own experiences and considering the reports in the literature, we feel that the operation is worth while, and should be done as a routine at the same time as the laparotomy which confirms inoperability. White also voices this opinion.

(3) *From the Extremities.*

CAUSALGIA

A painful extremity, accompanied by a hot, burning, spasmodic pain in the palm of the hand or sole of the foot, with serious, trivial, or no apparent cause, has long been felt to be due to sympathetic dysfunction. Section of peripheral sensory nerves has frequently been disappointing. The sympathetic nature of the origin of the pain may definitely be proved by a temporary blockage of all sympathetic nerves to the region, by means of a local anæsthetic, viz: injection into the stellate ganglion for the upper extremity, lumbar paravertebral block for the lower extremity. Causalgia has been found to be cured by a destruction or excision of the sympathetic ganglia controlling the affected limb, and in many cases is completely relieved by a peri-arterial sympathectomy.

Painful Amputation Stumps, Painful Ulcerative Lesions. Amongst the most difficult patients are often those with painful amputation stumps. They are notorious for succumbing to morphinomania or suicide.

Pathology. (1) *Normal Phenomenon.* The normal sensation after any amputation is the illusion of the presence of the amputated limb. The upper part of the centripetal conductor nerves still being present, the sense of the presence of the limb is only a simple physiological phenomenon, resulting from the disturbance of these axis cylinders.

(2) *Pathological Phenomena.* (a) The illusion of pain in the absent limb. In some amputated limbs painful neuromata form at the end of the nerves, the pain usually beginning some years after amputation. That the pain is present in the neuroma may be proved by injecting it with novocaine. If the neuroma is excised, it only grows again very quickly, but the case can usually be cured by sectioning the nerve at a distance, and then re-suturing it with minute care so that the minimum of neuroglia is formed at that point.

(b) Sympathetic pain in the stump. Around the neuroma may be formed a hard mass of fibrous tissue, and usually the most painful disturbances in amputation stumps are caused by pain reflected from

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CHAPTER IX

SYMPATHETIC DISEASES IN RELATION TO GYNÆCOLOGY

THE development of the surgery of the sympathetic nervous system from the gynæcological aspect lies largely to the credit of the French school, commencing with the pioneer work of Jaboulay in 1898. He was able to give at least temporary relief in cases of pelvic neuralgia by dividing the sacral sympathetic nervous connections after disarticulation of the coccyx. Leriche in 1921 investigated the effects of peri-arterial sympathectomy of the internal iliac artery, but it was the work of Cotté and Dechaumé in 1925 that finally clarified the position and established the undoubted value of sympathetic operations in this field.

All such procedures aim at the abolition of pelvic pain by the appropriate interruption of afferent sympathetic fibres, or reflex paths. Though precise knowledge of the exact relay stations and of the central connections is still very obscure, it is a fortunate fact that there are certain local strategic points where surgical attack may be conveniently and efficiently directed :

- (1) The nerves in relation to the uterus pass through the superior hypogastric plexus or "presacral" nerve.
- (2) The ovary is supplied by a sympathetic plexus accompanying the ovarian artery.
- (3) The plexus surrounding the internal iliac artery receives afferent fibres from the vulva.

It follows, therefore, that lesions in these regions may be treated by resection of the presacral nerve, and peri-arterial sympathectomy of the ovarian and internal iliac arteries respectively.

Cotté in 1925 noted six gynæcological indications :

- (1) Dysmenorrhœa, of intractable type.
- (2) Uterine hypoplasia, accompanied by scanty and painful menstruation.

this to the periphery by sympathetic fibres. In addition to pain, trophic and other vasomotor phenomena are present. In this type injection of novocaine into the neuroma has little or no effect, and denervation of the neuroma by neurotomy is without avail. In high amputations, peri-arterial sympathectomy has usually a happy and lasting result. In lower amputations, injection or removal of the sympathetic ganglia will be found necessary.

(c) Extremely painful hyperæsthetic stumps. Rare cases with extreme hyperæsthesia to light touch, but without pain to a firm grip, are probably due to a true neuritis spreading up the main nerves and affecting the meninges and cauda equina.

Clinical Considerations. The pain, which is situated in the stump rather than in the absent limb, is nearly always constant, and may amount to absolute torture. Therefore a complaint by a patient of a painful stump must not be taken lightly, and a careful examination should quickly be undertaken in order to find out the mechanism of the pain. The patient must not be allowed to become a morphinomaniac, and re-amputation should never be undertaken. The affected nerves do not respond well to injections of alcohol, nor do radio-therapy or diathermy benefit them. As already pointed out, resection of neuroma alone is of little avail, as the pain is only relieved until a new one re-forms.

Treatment. The treatment, therefore, should be undertaken early in patients who have not become morphinomaniacs, and the type of operation must be carefully decided beforehand :

- (1) For pain in the absent limb, a high neurotomy of the affected nerve, with the special precautions already laid down.
- (2) Sympathetic type pain needs peri-arterial sympathectomy or ganglionectomy.

The preliminary use of intranervous anæsthetic injections aids in the correct choice of treatment.

motor in function. In genital hypoplasia it may well be that the relative deficiency of muscular tissue compared to connective tissue permits an abnormal degree of venous stasis during menstruation. Pressure upon, or tension of, the uterine nerves may reflexly set up uterine contractions that are responsible for the typical spasmodic pain.

(c) There may be a neurotic or even hysterical basis, and in these cases operative intervention is strongly contra-indicated, but if the nervous element is only a contributory factor, the operation may still be considered (Cannon).

(d) Disturbance of the complicated endocrine balance may be at fault. The hormones, in all probability, exert their respective actions independently of the nervous control, but their effects may be conceivably influenced by alteration of the vascularity of the part (experiments of Bouin and Courrier in 1929).

(e) Cotté was able to demonstrate inflammatory changes (peri- or intra-fascicular sclerosis of the nerve with frequent neuroma formation) in excised portions of the presacral nerve itself, which opens up the possibility of dysmenorrhœa being sometimes due to a presacral neuritis.

In all these cases, resection of the presacral nerve effectually interrupts the passage of abnormal impulses along the sympathetic pathways, from whatever cause.

Sclerocystic Degeneration of the Ovary. This gynaecological *bête noire* represents a very real and ever-present problem. It may be associated with dysmenorrhœa or dyspareunia, in which cases it is likely to respond to presacral neurectomy. The ovarian nerves themselves do not pass through the superior hypogastric plexus, and their total extirpation is a more difficult and less satisfactory procedure. It may be achieved, however, by perivascular stripping of the ovarian artery at its origin from the aorta, or less satisfactorily in the utero-ovarian ligament.

Kraurosis Vulvæ. In cases of intractable pain due to trophic disturbances following ovarian deficiency at any age, peri-arterial sympathectomy of the internal iliac artery may give great relief. It is, of course, essential to differentiate this condition from leucoplakia vulvæ, a potentially pre-cancerous condition.

- (3) Menorrhagia of ovarian origin.
- (4) Pelvic neuralgia.
- (5) Vaginismus.
- (6) Sexual neuroses.

To these may be added cases of severe pain, due, for example, to kraurosis vulvæ and inoperable pelvic neoplasia.

Though most of the work is still in the comparatively experimental stage, there is no doubt that enormous benefit may be secured in carefully selected cases of dysmenorrhœa. The outstanding principle that arises from the available data is that a sympathetic operation must never be undertaken in the presence of an organic gynæcological lesion as a substitute for rational treatment of the causal condition. It may, however, be a useful and important adjunct.

Dysmenorrhœa. Though this term means literally "difficult" menstruation, and it is usual for civilised women to experience some degree of discomfort merging into vague pain while they are "unwell," the term generally is used to indicate an abnormal degree of menstrual pain sufficient to interfere seriously with work or pleasure. The condition may be divided into two classes :

- (1) Dysmenorrhœa associated with physical signs, either of local lesions or of general ill-health.
- (2) Dysmenorrhœa where there is no gross abnormality either locally or generally.

The ætiology of the latter condition is not clear, and the treatment has been correspondingly unsatisfactory.

(a) Some of these cases show varying degrees of uterine hypoplasia, e.g. the "cochleate" uterus with "conical" cervix, and "pin-hole" os externum; but even so the exact cause of the pain is obscure. Such cases are usually cured following parturition, or relief, which is at least temporary, may be gained by dilatation of the cervix. In both cases the beneficial effect is probably due to further uterine development from the "infantile" stage.

(b) Failing these avenues of amelioration, sympathectomy in intractable cases may be of enormous value, though again the rationale is not quite clear. Davis has recently demonstrated the fact that most of the uterine nerves terminate round the capillaries, especially in the corpus uteri in contrast to the cervix, and he infers that they are vaso-

CHAPTER X

THE KINETIC SYSTEM

UNDER the term Kinetic System are included those tissues especially associated with the control of energy exchanges in the body, viz. : the sympathetic nervous system, the adrenals, and the thyroid gland. Since 1921 attempts have been made to control the energy-transforming diseases by operations on the adrenal sympathetic system. In conditions of hyper-irritability or pathological stimulation of this system, denervation of the adrenal glands has been recommended as an efficacious method of treatment, provided no psychological condition is present, e.g. psychoses, psycho-neuroses, or hysteria.

(i) *Neuro-circulatory Asthenia.*

This is a state of sympathetic hyper-irritability, not due to hyper-thyroidism or psychic causes.

Symptoms. The cardinal symptoms are nervousness, weakness, and palpitations. Restlessness, easily induced fatigue, and constipation are frequently associated.

Physical Signs. The patient has anxious facies and mydriasis, often with hippus, together with flushed skin, dermatographia, and cold moist extremities. Tachycardia, sometimes paroxysmal in type, may occur from trivial causes. The glucose tolerance and basal metabolic rate are normal. In a marked case the following tests are found to be positive :

Viscero-ocular reflex : Epigastric pressure causes pupillary dilatation.

Somogyi's reflex : Deep inspiration causes pupillary dilatation.

Erben's reflex : Flexure of thighs and trunk causes slowing of the pulse-rate.

Treatment. The operation is adrenal denervation, i.e. the severing of the sympathetic nerves to the adrenal gland, care being taken not

Post-operative Results. Resection of the superior hypogastric plexus has no deleterious effect on the normal menstrual cycle. It is usual to obtain a "pseudo-menstruation" within 48-72 hours after the operation presumably due to intense uterine congestion, but the next "period" follows at the normal time. Rectal and bladder functions are not impaired, nor is there any interference with the processes of pregnancy and parturition.

Cotté, in a series of over 200 cases in which sympathectomy was combined with any necessary corrective procedures, reports that the results are far superior to those obtained when the ordinary gynæcological measures are carried out alone.

spinal anaesthesia (up to the second thoracic segment), which, in the absence of permanent tissue changes in the vessels, will abolish or greatly reduce the blood-pressure response to cold stimulus.

(A) *Adrenal Denervation.* As a result of this operation the patient becomes more stable and less nervous, and headaches are relieved.

Charles Mayo records an interesting case of paroxysmal attacks of hypertension over a period of two years in a woman of 33 years. The blood-pressure rose to 300-330 mm. Hg. and was accompanied by severe headaches. The duration of the attacks varied, the blood-pressure being normal between them. At the laparotomy an encapsulated vascular tumour was removed from the retroperitoneal tissue adjacent to the left adrenal gland. Microscopy showed hyperplastic ganglionic nerve tissue.

Result. When the patient was seen 5 years later, the blood-pressure was normal and the patient was quite free from symptoms.

In the literature are recorded several cases where disturbances of the blood-pressure were associated with tumours along the sympathetic chains in the mediastinum and upper abdomen. The majority of these proved to be malignant, but one or two were pathologically similar to the type described here.

For technique of Operation of Adrenal Denervation see page 3202.

(B) *Splanchnic Nerve Resection.* Studies on essential hypertension and the effect on this condition of section of the major and minor splanchnic nerves have been carried out by Brown, McK. Craig and Adson (*Proceedings of Mayo Clinic*, Sept. 5, 1934, p. 538).

Operative Technique of Splanchnic Nerve Section. The method of choice is the posterior intra-diaphragmatic approach, the nerves being sectioned as they descend through the diaphragmatic crura. No unusual risk or untoward post-operative discomfort resulted, nor were any symptoms referable to the partial denervation of the splanchnic circulation.

Results. There have been encouraging results in carefully selected cases, but the number of patients treated is as yet too small to attempt to draw definite conclusions.

(iii) *Hyperthyroidism.*

It has been suggested that hyperthyroidism occurs because the gland is very responsive to the requirements of metabolism, and excessive demands are made upon it by an upset in the adrenal sympathetic system. It is notable, too, that the factors causing

to injure the blood supply. (See under "Operative Treatment.") The opposite side is denervated ten to fourteen days later.

Results. On the day after the operation, marked amelioration of all symptoms should occur, namely, lessening of heart-consciousness; less nervous tension; diminished sweating; warm skin; less restlessness. Later but inconstant results are a disappearance of the associated constipation and indigestion. If these improvements are not noted after the first denervation, the second should not be done, as the diagnosis is incorrect. Geo. W. Crile has reported 93.8 per cent cures in 76 cases submitted to bilateral adrenal denervation.

(ii) *Essential Hypertension.*

In addition to the measures adopted in the medical treatment of this disease, there are two surgical procedures upon the sympathetic nervous system which are of some therapeutic value in reducing the blood-pressure and alleviating the symptoms.

These are: firstly, adrenal denervation; secondly, division of the major and minor splanchnic nerves. These may be employed singly or in combination.

It is, of course, futile to expect any operation on the adrenal sympathetic nervous system to produce any marked reduction of the systemic blood-pressure in the presence of organic narrowing of the arterioles.

Contra-indications to the operation are: (1) organic vascular disease; (2) severe degree of renal disease.

The most suitable cases are those in young patients and of short duration.

Investigation. A useful diagnostic aid in this disease is the blood-pressure reaction of a local cold stimulus.

Normal Response. Temporary increase of blood-pressure averaging 11 mm. systolic and 88 mm. diastolic.

In hypertension, years before the condition can be recognised by clinical or sphygmomanometric examination, there is a response of blood-pressure to cold stimulation of two or three times that observed in the normal subject. It is thought that this abnormal response is due to a hypersensitive vasomotor centre in the medulla.

The degree of organic, as opposed to spasmodic, change in the arterioles may be ascertained to some degree by the induction of a high

CHAPTER XI

METHODS OF INVESTIGATION

ALTHOUGH it is true that 90 per cent of cases of sympathetic dysfunction can be diagnosed on symptoms alone, all cases must be subjected to a thorough clinical examination. Specialised methods of investigation are not only a further aid to accurate diagnosis, but must also be undertaken in the majority of cases in order to determine :

- (1) The exact degree of pathological change present ;
- (2) The best mode of treatment ;
- (3) The prognosis.

Clinical Investigation. When taking the patient's history careful enquiry must be made of his habits, with special reference to alcohol, tobacco, and the partaking of rye bread.

An ordinary routine examination is undertaken of all patients, including a most careful elimination of all possible septic foci. Teeth, tonsils and sinuses are under suspicion in all cases, and if necessary radiography and bacteriology must be utilised in order that no focus is overlooked. The systolic and diastolic blood-pressures are always recorded, and all peripheral pulses palpated, e.g. in 50 per cent of cases of thrombo-angeitis obliterans, pulsation in the anterior and posterior tibial arteries is absent and is palpably diminished in 45 of the remaining 50 per cent.

Pathological Investigation. Every case of established or suspected sympathetic disease should have a Wassermann test of the blood, and urine and blood sugar examinations.

Special Methods of Investigation. The groups under which these special methods of investigation fall may be classified as follows :

- I. The peripheral blood-vessels.
- II. The visceral blood-vessels.
- III. The alimentary canal.
- IV. The renal tract.

thyroid crises in patients with hyperthyroidism are those conditions which cause an increased output of adrenalin, namely, pain, emotional excitation, focal infection, hæmorrhage, and asphyxia.

In this view adrenal denervation is a logical method of treatment. The operation is not proposed, however, as an alternative to thyroid operations, but rather as an aid to treatment in those cases of recurrent or residual hyperthyroidism following operations upon the gland.

The adrenal denervation may be combined with a further removal of thyroid tissue.

(iv) *Diabetes.*

In those cases of diabetes associated with hyperthyroidism the former is cured in 55 per cent of cases by the operation on the thyroid. In the remaining 45 per cent the diabetes may be benefited by adrenal denervation. Upon pure diabetes mellitus adrenal operations have not produced any appreciable improvement.

(v) *Epilepsy.*

On the theory that epilepsy results from rhythmic hyperactivity of the entire energy system of the body, Crile suggested and has carried out operations upon the adrenal glands for this condition, these glands being the chief controlling centre of the kinetic system. In a series of cases of epilepsy treated by bilateral adrenal denervation there was marked improvement or apparent cure of the disease in about one-third of patients. In the remainder no improvement was noted (Crile). This method of treatment is by no means an accepted procedure as yet, and there remains much work still to be done.

(vi) *Peptic Ulcer.*

Adrenal denervation has been performed as a primary operation in the treatment of peptic ulcer, and also as a secondary measure in those cases where medical and surgical procedures have failed. Although a high percentage of successes has been reported in the literature, the case for adrenal denervation in this disease remains *sub judice*.

method of testing the vasomotor mechanism, especially with reference to the peripheral circulation, is by recording a series of skin temperatures before and after alteration of the environmental temperature.

Technique. The patient lies naked, except for a perineal pad and, in the female, a brassière, in a warm room of constant temperature (25 degrees Centigrade (77 degrees Fahrenheit) is the optimum). At the end of one hour skin temperature readings are taken at previously marked spots on the surface of the body (see fig. 1786).

The only instrument necessary for the estimation of skin temperatures is a simply constructed thermometer, almost identical with the ordinary clinical thermometer, except that it has not the "clinical" principle; that is to say, the mercury from a small bulb can move freely up or down the capillary tube, and each reading may be taken in a very few seconds. We have had a large number of these thermometers made for us by L. H. Marks (see fig. 1787). These are graduated from 65° or 70° F. to 105° F. on one side of the magnifying column, and from 20° C. to 42° C. on the opposite side. We have found them accurate, rapid in action, and to have given uniformly excellent results. Expensive and cumbersome electrometric thermometers are unnecessary, and are no more accurate than the thermometer here described.

For all practical purposes we now find it sufficient to take the mouth temperature and the following points on both sides of the body:



Fig. 1787.—THE SKIN THERMOMETER. (By L. H. Marks.)

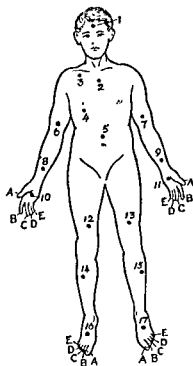


Fig. 1786.—DIAGRAM SHOWING THE POINTS AT WHICH SKIN TEMPERATURES ARE TAKEN (INTERDIGITAL SPACES NOT SHOWN).

axilla, elbow, wrist, interdigital spaces, tips of digits; groin, knee, ankle, interdigital spaces and tips of digits. A graph is made of these readings (fig. 1788). The subject is then completely covered, except for the face, with a warmed, light rubber sheet and wrapped in three

I. *The Peripheral Blood-vessels.* The vasomotor centre in the medulla is sensitive to changes in the body temperature of from 0.01°C . to 0.04°C . One of the chief functions of this centre, and of the vasomotor system as a whole, is the control of the body temperature by means of the regulation of heat loss and gain from the skin in response to changes in environmental temperatures. This control is obtained by variations in the degree of constriction or dilatation of superficial capillaries, arterioles and venules, and is of necessity associated with variations in the skin temperature, which is low with vasoconstriction and high with vasodilatation, and changes from moment to moment throughout the whole of life with alterations of environmental temperature.

In ordinary daily life, the peripheral vessels of exposed portions of the body, and of the extremities, may be said to be in a condition of physiological constriction when the being is up and about. This vasoconstriction only relaxes in the portions of the body covered by warm clothing, or in a warm room, or, most thoroughly of all, upon going to bed, wherein the temperature becomes sub-tropical in approximately one hour. By this time the temperature of the skin over the whole body attains an almost uniform level of somewhere in the region of 98.4 degrees Fahrenheit (with the possible exception of the exposed parts of the face), i.e. peripheral vasoconstriction is in relative abeyance.

Pathological hypertonic vasoconstriction leads, as we have already pointed out, to pathological changes in the walls of the arteries and arterioles, and when the factors are brought into play which would produce a rise of surface temperature in a normal subject, the damaged vessels fail to respond (i.e. fail to dilate). Skin temperature readings, therefore, give, on the one hand, an accurate estimate of the degree of dilatation still possible in the affected vessels, and on the other, the degree of fibrosis and organic change.

Inhibition of vasoconstrictors may be attained by :

- (1) Increase of environmental heat.
- (2) General fever.
- (3) A general anæsthetic.
- (4) A local, regional, or spinal anæsthetic.

Methods of Investigation of a Vasospastic or Vasoconstrictive Disease by Increase in Environmental Heat.

In our experience the simplest and perhaps the most efficacious

woollen blankets (see fig. 1790). One hour later, the skin temperature readings are taken at the same points, and a second graph is made. In a normal patient, or in one with such early vasospasms that no fibrosis has occurred in the walls of the peripheral vessels, the second

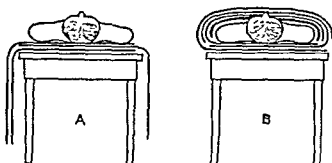


Fig. 1790.—DIAGRAM TO ILLUSTRATE THE "BLANKET TEST" FOR INCREASING THE ENVIRONMENTAL TEMPERATURE.

graph becomes almost a straight line at or a little below the level of the mouth temperature (see fig. 1789). A limb which is the seat of organic arterial disease shows in the first instance a skin temperature some degrees lower than a normal limb, or than the opposite limb if

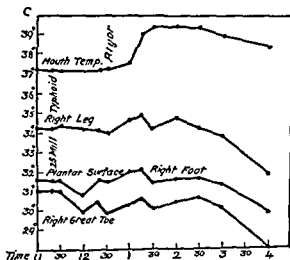


Fig. 1791.—CHART TO ILLUSTRATE THE "VASOMOTOR INDEX" IN A CASE OF THROMBO ANGITIS OBLITERANS.
Index = 0.

unaffected by the disease. On increasing the environmental temperature, the amount of rise in skin temperature is proportional to the ability of the superficial vessels to dilate; in other words, it indicates the proportion of muscle to fibrous tissue in their walls.

By this method the patient is put to no discomfort or pain. Apart from a simple skin thermometer no special apparatus is required, and

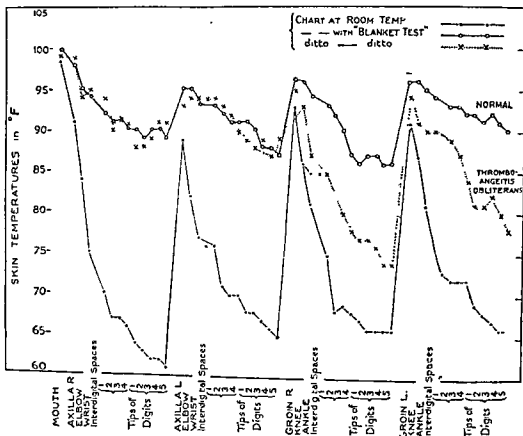


Fig. 1788.—SKIN TEMPERATURE CHART SHOWING NORMAL RESPONSE TO ENVIRONMENTAL ("BLANKET") TEST, AND THE RESPONSE IN A CASE OF THROMBO-ANGITIS OBLITERANS. NOTE THAT THE CHART INDICATES ABOUT A FIFTY PER CENT DEGREE OF ORGANIC STENOSIS.

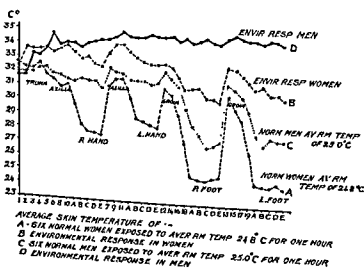


Fig. 1789.

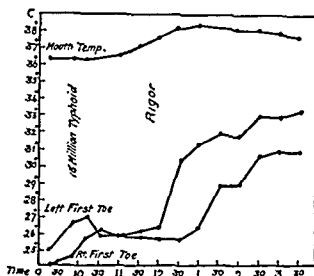


Fig. 1793.—CHART TO ILLUSTRATE THE "Vasomotor Index" IN A CASE OF RAYNAUD'S DISEASE.

Index=4.

Of the other methods available to produce inhibition of vasoconstriction none is more satisfactory than the foregoing, and all are accompanied by greater discomfort to the patient, and more trouble for the investigator. They are therefore simply enumerated:

(A) Skin temperature readings are recorded during variation in the environmental temperature by a radiant heat bath or by immersion of the extremities in water at 45°C .

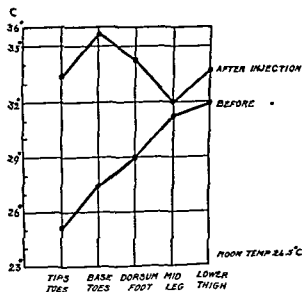


Fig. 1794.—SKIN TEMPERATURE CHARTS FROM A CASE OF VASOSPASM OF THE LOWER EXTREMITIES, BEFORE AND AFTER PARAVERTEBRAL INJECTION OF THE LUMBAR SYMPATHETIC TRUNK (R).

the test can be carried out in a warm consulting room, or, as we find very satisfactory, in a warm anæsthetic room adjacent to an operating theatre. From the recorded temperatures, Brown estimates a "vasomotor index." The index=

$$\frac{\text{Skin Rise} - \text{Mouth Rise}}{\text{Mouth Rise}}$$

It has been found that operation is not advisable unless the index is 1.5 or more. In our practice this index has not proved as valuable as appeared at first sight.

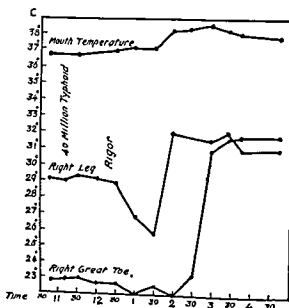


Fig 1792.—CHART TO ILLUSTRATE THE "VASOMOTOR INDEX" IN A CASE OF THROMBO-ANGELITIS OBLITERANS.

Index: R. Leg=5.3

L. Leg=3.0

The proportion of rise of skin temperature under increased environmental heat, or under inhibition or paralysis of all vasoconstrictors by other methods, compared with the rise which takes place in the opposite, if non-affected, limb, or in a normal limb, is a direct index of the proportion of recovery which may be expected by sympathectomy (see fig. 1788). The degree of organic change is therefore accurately estimated, prognosis becomes certain, and the ultimate result that may be expected from operation is obvious to the investigator and may be demonstrated to the patient and relatives. Skin temperature charts will also indicate the level at which amputation is safe in those cases where this procedure is necessary.

(E) A whole limb may be investigated by paravertebral sympathetic nerve block.

For the upper extremity: stellate and second thoracic ganglia.

For the lower extremity: the lumbar ganglia (see fig. 1794).

This method is especially valuable in differentiating sympathetic from other types of pain.

(F) Both lower extremities may be investigated under the influence of a spinal anæsthetic (see fig. 1781).

OTHER SPECIAL TESTS

Some workers have deemed it advisable to test the subcutaneous temperature. This, of course, demands an electrometric thermometer, attached to a fine needle, which is passed into the subcutaneous tissues. It would appear to be unnecessary, and furthermore, less trauma than this has precipitated gangrene in cases of peripheral vascular disease.

The capillaries themselves may be observed microscopically, and their size and movements noted.

The degree and area of sweating is sometimes of interest, though perhaps more important is the area over which sweating is abolished after paravertebral nerve block.

Calorimetric Estimations, i.e. estimations of heat elimination from a limb. Stewart's calorimeter is used to record the rate of heat elimination from the limb under similar conditions to those used for skin temperature records and gives similar results (fig. 1797).

Oscillometric Readings, with a Pachon's oscillometer, show variations in the changes in pulse volume in different conditions of organic vascular disease, with special reference to the larger vessels. Johnson uses a delicate plethysmograph which, adjusted on a finger, records changes in the pulse volume of the digit. A bubble in a capillary tube indicates the volumetric changes, which are recorded photographically.

The Histamine Test. Intradermal injection of 0.1 cc. of one in a thousand histamine (ergamine acid phosphate) does not produce the characteristic weal and flare when the circulation is inadequate. It is by no means an accurate estimation of arterial disease.

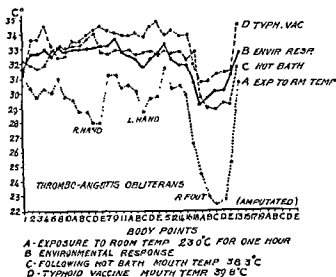


Fig. 1795.—A CHART OF SKIN TEMPERATURES IN THROMBO-ANGIITIS OBLITERANS UNDER VARIOUS CONDITIONS.

(B) Similar skin temperature readings are taken both before and while the patient is under the influence of a general anæsthetic.

(C) A general febrile condition may be brought about by the intravenous injection of a foreign protein. The most satisfactory substance to use is from 25 to 75 million triple typhoid vaccine. Typhoid H. antigen has also been recommended.

(D) Peripheral nerves may be investigated by local nerve block, e.g. the ulnar nerve at the elbow, the posterior tibial nerve in the calf, or the great sciatic nerve in the thigh.

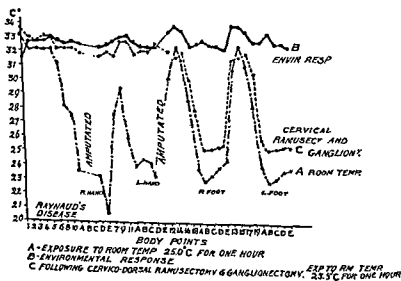


Fig. 1794.—A CHART OF SKIN TEMPERATURES IN RAYNAUD'S DISEASE UNDER VARIOUS CONDITIONS.

II. *Visceral Vascular Lesions.* Retinoscopy in pigmentary degeneration of the retina may be undertaken in order to ascertain the degree of dilatability possible in the retinal vessels, before and after novocaine block of the stellate ganglion or the induction of fever, as already described in the appropriate section.

The indications and methods of investigation with reference to angina pectoris have also been previously detailed.

III. *The Alimentary Canal.* Spasms in the region of the cardiac sphincter, pylorus and recto-sigmoid sphincter, and their methods of investigation by means of X-rays after a barium swallow, meal, or enema respectively, together with a similar investigation undertaken after temporary paralysis of the controlling sympathetic ganglia, e.g. paravertebral thoracic or paravertebral lumbar nerve block, or following spinal anaesthesia, have been carefully described under their appropriate headings.

IV. *Renal Sympathetico-Tonus.* Radioscopy of the renal pelvis, first in the untreated condition, and secondly after either (a) injection of eserine, or (b) lower thoracic and upper lumbar ganglion block, or (c) high spinal anaesthesia, indicates the advisability or otherwise of operating upon this type of case (see Chapter VII).

V. *Investigation of Pain of Sympathetic Origin.* A paravertebral sympathetic nerve block performed at the appropriate level is the most useful test in the differentiation of pain of uncertain origin, and gives an accurate estimation of the advisability or otherwise of direct attack upon the sympathetic ganglia. The indications for treatment are described under "*Sympathetic Afferent Nerve Pathways*" (see Chapter VIII), and technique under operative procedures (see page 3188).

The Intradermal Saline Test. A weal raised by the intradermal injection of normal saline is absorbed more rapidly in a limb which is the seat of vasoconstriction than in a normal limb.

Arteriography. Ordinary X-ray examination of the arteries will show the presence or absence of calcareous deposits. An arteriogram taken after an intra-arterial injection of thorotrast gives further indication of the degree of patency of the larger vessels, and the sites at which occlusions occur, but is of no value in distinguishing between spastic and organic occlusions.

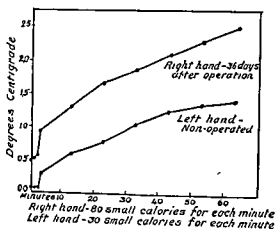


Fig. 1797.—A CHART SHOWING HEAT ELIMINATION (RECORDED BY A SKIN CALORIMETER) FROM THE HANDS IN A CASE OF RAYNAUD'S DISEASE. (SAME CASE AS FIG. 1776.)

R. Side . After cervical ganglionectomy.
L. Side : No operation.

Buerger's Test. Buerger pointed out that in a patient with thrombo-angeitis obliterans, if the patient lies in the supine position, when the leg is raised from 45 to 90 degrees, i.e. towards or to the vertical, a marked ischaemia develops in from 30 to 180 seconds. Lowering the leg to from 65 to 90 degrees below the horizontal causes marked reactionary rubor (see fig. 1779). (In the normal case, of course, neither excessive pallor nor rubor occurs.)

The Angle of Circulatory Efficiency (see fig. 1779). This is learned by raising the patient's leg to the vertical for three minutes, or until the pallor is no longer progressive, and then gradually lowering the leg; the angle at which a normal pink hue returns is the angle of circulatory efficiency. In Buerger's disease this is usually below the horizontal, and generally at about 60 degrees.

- V. Lastly all cases, even though submitted to surgery, whether by direct attack upon the sympathetic nerves or ganglia, or by amputation, should have concomitant and subsequent medical treatment.

Treatment may be classified as follows :

(A) General Treatment.

- (1) Postural.
- (2) Treatment of the underlying cause.
 - (a) Focal infections.
 - (b) Diabetes.
 - (c) Syphilis.
 - (d) Other infection, due to constitutional diseases, e.g. ergotism, etc.
- (3) Diet.
- (4) Injections.

(B) Local Treatment.

- (1) Heat.
- (2) Diathermy.
- (3) Radiations.
- (4) Active exercises.
- (5) Passive exercises.
- (6) Electro-therapeutic treatment.

General Medical Treatment. Rest in bed is the first essential, with warm light clothing and absence of draughts and cold. If the case is not severe enough to warrant confining to bed, and in any case following surgical interference with the sympathetic nerves, woollen clothing to the extremities, with woollen socks and gloves and fur- or wool-lined boots and gloves, should be used.

GENERAL MEDICAL TREATMENT

Careful manicure and pedicure are important.

Diet. Smoking should be restricted or stopped altogether, and, of course, rye bread must be cut out of the dietary to eliminate the possibility of ergot poisoning. Excessive intake of alcohol is injurious, but

CHAPTER XII

TREATMENT

UNDER the various sections dealt with above, treatment has already been indicated to a very large extent in the majority.

In this section it is proposed to outline :

- (1) various medical methods of treatment of sympathetic diseases of the blood-vessels, together with their indications and contra-indications ;
- (2) detailed account of surgical treatment, together with operative technique.

A. MEDICAL TREATMENT OF SYMPATHETIC DISEASES OF BLOOD-VESSELS

No dogmatic statement can be made to cover all types of vascular vasomotor disorders, and a wide clinical experience and a most careful investigation of each individual case is necessary before deciding upon a definite course of treatment. Although experience has shown that surgical interference with the sympathetic ganglia should be undertaken too soon rather than too late, certain broad lines are recognised as indicating types of cases which respond favourably to medical treatment. These are as follows :

- I. Mild cases, which, with rest and medical treatment, develop adequate collateral circulation and can return to work.
- II. Those cases which improve rapidly with medical treatment.
- III. Cases with a minimal amount of disability, and which show no evidence of progression of the disease.
- IV. Those patients who are rapidly developing circulatory compensation, and in whom the ulcers are healing, and who have a limb 80 per cent functional.

of its vasodilator action on all arterioles, but particularly on those of the periphery, i.e. the skin and muscles.

Chemical Composition. This is as yet unknown, but it is practically free from albumen.

Dosage. It is standardised in units (by blood-pressure tests in dogs) and given by intramuscular injection, from $\frac{1}{2}$ to 2 units twice a day or by oral administration in doses of 9 to 12 units thrice daily.

Lacarnol. This is a nucleoside tissue extract obtained from heart muscle, striped muscle and other mammalian tissues. Although somewhat similar in its action to padutin, lacarnol has a selective dilator action on the coronary and other larger arteries, contrasting with the smaller vessels primarily affected by padutin.

Thus lacarnol is likely to be better for such conditions as angina pectoris, whereas padutin is more effective in peripheral vascular disease, e.g. thrombo-angecitis obliterans or Raynaud's disease.

Carnacton is a preparation made by the Cavendish Chemical Co., and is given in doses of ten minims three times a day by mouth, increasing by five minims weekly to thirty minims three times a day. It appears to have a powerful specific action upon the peripheral vessels, and we have seen several patients derive no small benefit from its exhibition.

Silbert has suggested lowering the blood viscosity by intravenous injection of hypertonic saline: 300 cc. of 5 per cent saline are given three times weekly for a monthly course.

Local Treatment. Medical diathermy and the quartz light are occasionally useful in encouraging vasodilatation. Buerger's exercises may assist in restoring muscular power to the diseased vessels. The patient's limbs (usually the lower) are placed for three minutes elevated to 60 degrees from the horizontal, then three minutes hanging vertically downwards, and then five minutes in a horizontal position.

An infra-red lamp may be used at the same time. Contrast foot baths are often a valuable aid to treatment.

Passive Vascular Exercises. This method of treatment is advocated by Hermann and Reid, of Cincinnati, U.S.A. By means of a special apparatus called the "Pavæx" unit, a limb may be subjected to rhythmic and controlled variations in environmental pressure. The

it is hardly justifiable to forbid it altogether. A large fluid intake is desirable.

Focal Infections. It is most important that any such focus should be adequately dealt with, e.g. apical dental abscesses, often recognisable only by X-ray; sinus infections; tonsillar, tubal or appendicular disease, etc., etc.

Other diseases. Syphilis and diabetes mellitus are commonly associated with vascular changes and must always be searched for and adequately treated if present.

Antispasmodics. The natural antispasmodic to the sympathetic nervous system is stimulation of the parasympathetic system. The direct parasympathetic hormone is acetyl-choline, which has been found of great benefit in early vasospastic conditions. Its effect is said to be augmented by eserine, and more so by the modern derivative of physostigmine, namely, prostigmin. This allegation is certainly true of the abdominal viscera, but we are unaware that it has been proved in regard to the peripheral vessels.

Specific Injections. Of recent years considerable advance has been made in the treatment of peripheral vascular lesions by injection of various substances.

The non-specific protein shock therapy, e.g.:

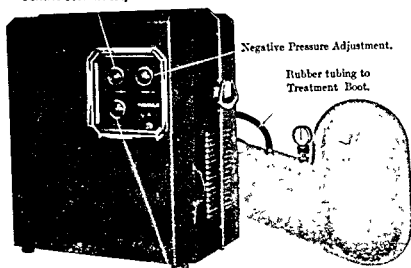
Typhoid Anti-toxin, T.A.B. This has already been mentioned in Methods of Investigation (Chapter XI). The peripheral vasodilatation which ensues on artificial pyrexia induced in this way is valuable as a means of improving the peripheral circulation. A series of injections at weekly intervals may result in considerable improvement in the milder forms of arterial disease, i.e. when vasospasm only is present.

Dosage. 25 to 75 million units of T.A.B. are injected intravenously.

Typhoid H Antigen is also said to be efficacious (Dickson Wright).

Padutin is a substance formed in the pancreas and passed into the circulation as an internal secretion of that gland. It is excreted in small amounts in the urine. It has been isolated from the urine by Bayer Products Ltd., and named the "vascular hormone," on account

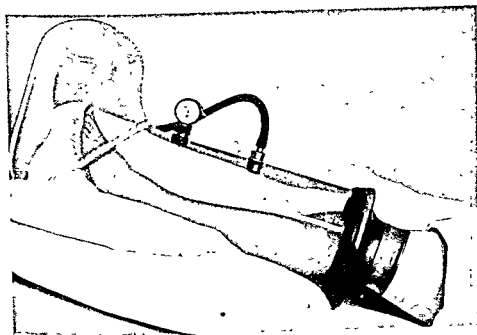
Positive Pressure Adjustment.



By courtesy of Short & Mason Ltd.

Frequency or Rate Adjustment.

Fig. 1798.—THE "PAVEX" UNIT AND BOOT.



By courtesy of Short & Mason Ltd.

Fig. 1799.—THE "PAVEX" TREATMENT BOOT WITH MANOMETER ATTACHED. NOTE THAT THE FOOT AND LEG HAVE BEEN ELEVATED SEVERAL INCHES ABOVE THE LEVEL OF THE PATIENT'S HEART TO FACILITATE THE RETURN OF VENOUS BLOOD FROM THE EXTREMITY. (After Hermann and Reid.)

pressure and suction are transmitted to an air-tight treatment chamber which encases the limb, the positive and negative phases being controlled both in strength and duration from the dial of the unit (see figs. 1798 and 1799).

In a series of over three thousand treatments to 51 patients suffering from advanced organic obliterative arterial disease, the authors draw the following conclusions: Calorimetric evidence of an increase in the circulation occurred in all cases, and as many as 83 per cent gained varying degrees of relief from their symptoms. The authors conclude that this form of therapy is the most effective means of developing the collateral circulation of the extremities of patients with extensive organic obliterative arterial disease. This method of treatment is now in very extensive use throughout the United States of America.

Electro-therapeutic Treatment. *Sinusoidal Currents* are sometimes of value in promoting the remaining healthy vessels to expand and function as collaterals.

B. SURGICAL TREATMENT

Radical Operations. Sympathetic Ganglionectomy, Ramisectomy, Sympathetic Trunk Section.

Sympathectomy offers the greatest chance of improvement or cure in the vast majority of diseases due to sympathetic dysfunction. The objects of undertaking a radical attack are, of course, to remove all vasoconstricting nerve fibres, which results in an improvement of the collateral circulation, removes the spasm of the affected vessels, and so allows the maximum amount of dilatation that any existing organic changes will permit. The onset of organic stenosis of vessels may be prevented in those which are the seat of vasospasm, or the progress of organic fibrous changes may be arrested. In cases where gangrene has already appeared, a radical operation upon the sympathetic ganglia frequently allows amputation to be performed at a lower level than would otherwise be the case.

Sympathectomy has a definite effect in relieving pain in some conditions, e.g. thrombo-angeitis obliterans.

Indications. All early vasospastic cases whose economic status makes it impossible for them to afford prolonged medical treatment

aspect of which, running vertically downward, is the phrenic nerve. The nerve must be carefully retracted medially, and the scalenus anticus divided just above its insertion. The second part of the subclavian artery is now exposed and dissected free, so that it may be drawn downwards and forwards. It is seldom necessary to divide the thyroid axis, and the vertebral artery should always be left intact.

Sibson's fascia is seen attached to the inner border of the first rib, from which it should be carefully separated, and beneath this the

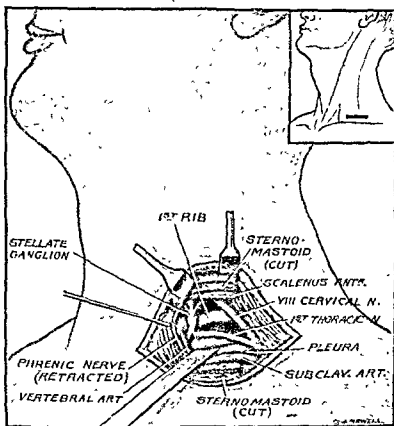


Fig. 1800.—OPERATIVE EXPOSURE OF THE STELLATE GANGLION BY THE ANTERIOR APPROACH.

pleura must be freed from the inner aspects of the upper three ribs and the bodies of the corresponding vertebræ. Lying on the heads of the ribs the thoracic sympathetic trunk is seen, and it should be carefully raised and cut across just below the second thoracic ganglion.

The stellate ganglion is easily identified as a large mass of nerve tissue lying on the head of the first rib. The first intercostal space runs from this position, not only in a downward, but also in a definitely backward direction. The sympathetic trunk may be traced downwards into the first intercostal space, where the second thoracic ganglion

are much better operated upon at the outset. All slowly progressive cases, and all cases with already established organic changes, should be operated upon with as little delay as possible.

OPERATIVE TECHNIQUE

General Remarks. In accordance with modern surgical practice, adequate pre-operative medication is administered to all patients. The choice of general, local, or regional anæsthesia rests with the individual surgeon. In practice, evipan, with or without nitrous oxide and oxygen, has been found satisfactory, and may be supplemented by local infiltration or a spinal anæsthetic. Each operation is a definite anatomical study; careful attention must be paid to the identification of landmarks, and especially in the handling of nerve structures. As these operations are often carried out in loose cellular areas careful attention to hæmostasis is essential, and in deep wounds Cushing's clips are found valuable. Where large areas have been opened up, post-operative drainage should be instituted for from twenty-four to thirty-six hours. After-care is detailed under the heading of Medical Treatment, and in certain cases must include special treatment peculiar to the condition, e.g. in poliomyelitis the re-educative treatment of muscles

SYMPATHECTOMY FOR THE UPPER EXTREMITY

Cervical sympathectomy, cervico-thoracic ganglionectomy, or stellectomy.

In this operation, the inferior cervical and the first thoracic ganglion (usually fused as the stellate ganglion) must be removed, together with the second thoracic ganglion (in order to include the nerve of Kuntz), and the small intervening portion of the thoracic chain.

(A) *Anterior Approach* (fig. 1800). *Position.* The patient lies in the dorsal position with the shoulders on a suitable support in order to cause extension of the neck. The *incision* should be one inch, never more than one and a half inches, in length, half an inch above the junction of the inner third and outer two-thirds of the clavicle, and extends through skin and platysma. The external jugular vein will frequently have to be divided between ligatures. The clavicular head of the sterno-mastoid may be incised or retracted medially, exposing the omo-hyoid muscle. The latter is divided, and beneath it is seen the beginning of the scalenus anticus muscle, on the anterior

length. It is first cut across at the outer end and then at its neck ; the tip of the transverse process must also be included. The pleura is now elevated from the sides of the bodies of the vertebræ and the thoracic trunk is seen lying in juxtaposition to the heads of the upper ribs, but deep to, i.e. anterior to, the roots of the brachial plexus. The trunk is divided below the 2nd thoracic ganglion, and to do this it may be found convenient to remove in addition part of the 2nd rib. The sympathetic is gently drawn downwards and its rami divided *seriatim*, until it is eventually cut across above the upper limit of the stellate ganglion. Complete hæmostasis is effected, and drainage is seldom, if ever, necessary. The opposite side is usually operated upon at the same sitting. As a final step, about half an inch of the spinous processes of the exposed cervico-dorsal vertebræ is removed, and the wound closed in layers.

SYMPATHECTOMY FOR THE LOWER EXTREMITY

Lumbar Ganglionectomy. In order to denervate the lower limb of its vasomotor nerves, it is necessary to remove that part of the lumbar trunk which supplies grey rami to the second, third and fourth lumbar nerves. If an unilateral sympathectomy is desired the approach may conveniently be made from the respective loin, or this route may be chosen for a bilateral effect, where a transperitoneal operation is contra-indicated.

(A) *The Operation from the Loin* (fig. 1802). *Position.* The patient is placed on his side, with an appropriate support under the lower ribs in order to give greater accessibility.

Procedure. (1) An incision is made in the skin parallel to the outer border of the erector spinæ muscle. It should extend from about half way along the last rib, downwards and forwards towards the crest of the ilium, and then forwards almost reaching the anterior superior iliac spine. This incision includes the subjacent fascia, and the combined flap should be reflected forwards exposing the muscular layer.

(2) The muscles of the abdominal wall are now incised just above the iliac crest (external and internal oblique with the transversalis muscles).

(3) The lumbar fascia is incised vertically along the outer border of the quadratus lumborum, and the fascia transversalis divided.

is found. The trunk should be lifted up and cut across just below the second thoracic ganglion. The divided trunk is now elevated and freed from below upwards; all rami are divided step by step until the cervical trunk is cut across just above the inferior cervical ganglion, i.e. the upper limit of the stellate ganglion. Two or three sutures unite the platysma muscle, and the skin edges are closed, leaving a small rubber drain brought to the outer ends of the skin incision.

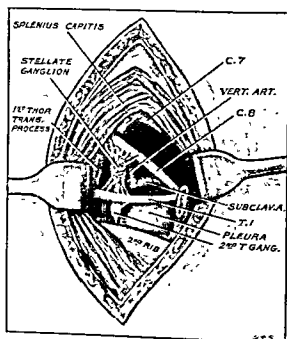


Fig. 1801.—OPERATIVE EXPOSURE OF THE STELLATE GANGLION BY THE POSTERIOR APPROACH.

(B) *Posterior Approach* (fig. 1801). This approach is commonly used in the United States of America, but very seldom in this country. It is not recommended.

Position of patient. The patient lies prone with the arms hanging over the edges of the table, the neck being flexed and the head suitably supported.

Incision. The skin is incised in the mid-line from the spine of the 6th cervical to the spine of the 4th thoracic vertebra. The superficial muscle layers are incised on the appropriate side of the spinous processes. In turn are divided the trapezius, rhomboids, and serratus posticus superior, and the whole retracted laterally. The erector spinæ is exposed thereby, and split longitudinally, so that the transverse processes of the 1st and 2nd thoracic vertebræ are bared.

A section of the 1st rib is now resected subperiosteally, 3 cms. in

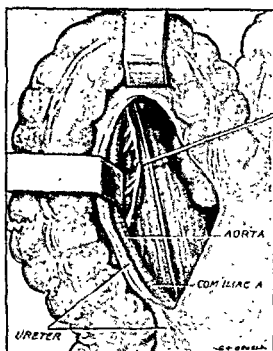


Fig. 1803.—TRANSPERITONEAL EXPOSURE OF THE LEFT LUMBAR SYMPATHETIC CHAIN. NOTE THE MEDIANLY DIRECTED BRANCHES—"THE LUMBAR SPLANCHNIC NERVES."

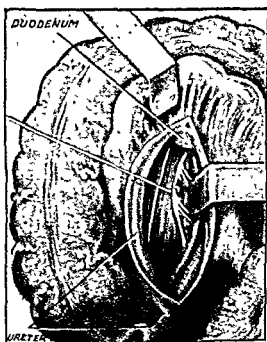


Fig. 1804.—TRANSPERITONEAL EXPOSURE OF THE RIGHT LUMBAR SYMPATHETIC CHAIN.

(4) The peritoneum is stripped forwards and inwards, using retractors, until the inner border of the psoas is well exposed.

(5) The lumbar trunk is revealed lying on the lateral aspect of the bodies of the vertebræ. A portion is resected extending from the second lumbar vertebra to the brim of the pelvis.

(6) The muscle layers are sutured.

(7) The skin edges are opposed, leaving a rubber drain.

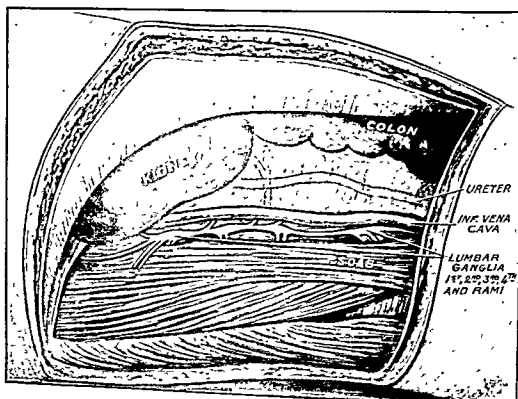


Fig. 1802.—LUMBAR GANGLIONECTOMY FROM THE LOIN. (R.)

(B) *Anterior or Transperitoneal Approach.* *Position.* The patient is placed in the dorsal position, with suitable shoulder rests on the table, and with a high degree of Trendelenburg.

Procedure. A six-inch right paramedian incision is used, starting two inches above the umbilicus, and the abdomen opened.

(a) *Left side* (see fig. 1803):

(1) The peritoneum is incised along the outer side of the descending and upper pelvic colon. The colon is mobilised and drawn over to the right.

to radical operation for vasomotor dysfunction, as has already been detailed under General Medical Treatment.

Owing to the fact that, in addition to the vasoconstricting fibres, section of nerves supplying the sebaceous and sweat glands also occurs, dryness of the skin may be a troublesome sequel. It may be relieved by the local application of hydrous wool fat.

Sequelæ and Results. Painful, blue and cold extremities become warm, of a satisfactory colour, and free from pain, and remain so for many years. The attached tables (see pages 3134 and 3136) extracted from reports from the Mayo Clinic are self-explanatory, and show the high percentage of cures attained by radical surgery in early cases, and the marked improvement in cases dealt with at later stages of the disease.

Extremely rare cases have been reported when sensitisation of the peripheral vessels appears to occur from ten to fourteen days after the operation, and the effects of a successful operation appear to be completely nullified. This sensitisation is alleged to be due to the action of sympathin, and it has been suggested and proved, in the rare cases where necessity has arisen, that bilateral denervation of the adrenal glands has effectively overcome this sensitisation.

After stelletomy Horner's Syndrome is not conspicuous, especially if bilateral, and is usually quite unnoticed by the patient. Vision, of course, is in no way impaired.

Operations upon the lumbar sympathetics, carried out according to the technique outlined above, do not interfere with any other vital sympathetic pathways, and undesirable sequelæ, such as sterility and psycho-neuroses, have been avoided.

PALLIATIVE SURGICAL TREATMENT

Paravertebral Injections. Injection into the sympathetic ganglia may be undertaken either for :

- (a) Investigation, or
- (b) Treatment.

The technique of each is the same. The injection substance in the first instance is novocaine, or some similar anæsthetic, and in the second case is alcohol, 70, 80 or 90 per cent.

(2) Dissection proceeds behind the peritoneum until the inner border of the psoas muscle and the vertebral bodies are exposed, care being taken not to damage the ovarian or spermatic vessels, or the ureter. On the lateral aspect of the vertebral bodies is found the lumbar trunk overlapped by the inner border of the psoas.

(3) The second lumbar ganglion should be located, and may be found by means of its communication with the second lumbar nerve. Divide the lumbar trunk just above this ganglion.

(4) The trunk is now gradually freed downwards, dividing all rami that are met with, until the trunk passes behind the left common iliac artery. At this point the trunk is again divided.

(5) Hæmostasis is secured and some of the lumbar veins may need to be ligated.

(6) The colon is replaced, and the peritoneum sutured where it was previously incised.

(b) *Right side* (see fig. 1804) :

(1) The peritoneum is incised along the outer side of the cæcum and ascending colon. The colon is mobilised and drawn inwards.

(2) The inferior vena cava is drawn forwards and to the left, thus exposing the lateral aspect of the vertebral bodies. This exposes the right lumbar trunk lying close to the inner border of the psoas.

(3) The trunk is divided high up, but if it is impossible to include the rami to the second lumbar nerve it is of little consequence.

(4) Dissection is continued, similarly to the left side, and resection completed at the point where the trunk is lost to view behind the right common iliac vein.

(5) The cæcum is replaced and the lateral peritoneum sutured.

Alternative Approach to the Right Lumbar Chain. The root of the mesentery may be drawn upwards, and an incision made over the lower two inches of the inferior vena cava. Care must be taken not to damage the vessels running in the root of the mesentery, or the third part of the duodenum. Both these may, with care, be retracted upwards without damage. The inferior vena cava is retracted to the left, and the remainder of the operation proceeds as described above.

Both sides having thus been completed, the anterior abdominal wall is closed in layers.

Post-operative Care. Careful medical treatment is always undertaken in the post-operative care of patients who have been submitted

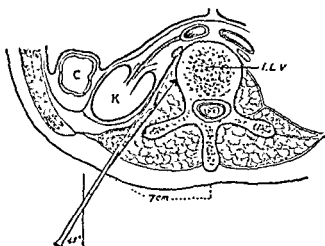


Fig. 1805.—PARAVERTEBRAL INJECTION OF THE LUMBAR SYMPATHETIC TRUNK. (After Labat.)

See text for description of technique.

C. Colon.
K. Kidney.
I.L.V. 1st Lumbar Vertebral Body.

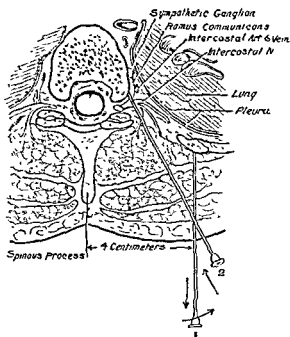


Fig 1806.—PARAVERTEBRAL INJECTION OF THE THORACIC SYMPATHETIC TRUNK (After Labat.)

Needle 1 is inserted as shown and after making contact with the inferior border of the rib its position is changed to 2. It is then advanced about 3 cms. further and should strike the body of the vertebra close to the intervertebral foramen. (Labat)

As a test of sympathetic dysfunction, prior to operation upon the ganglia in either the lumbar or the cervico-dorsal regions, a one or two per cent solution of novocaine, procaine, or percaïne is injected into the retroperitoneal or retropleural cellular tissue, respectively, in the region of the sympathetic fibres under investigation. By this technique it is almost always possible to obtain sympathetic paralysis, if sufficient fluid is used. When local anæsthetic is used prior to an injection of alcohol, only a small quantity, 5 to 15 minims, should be utilised, and as soon as peripheral tests have shown that this has affected the desired ganglia, then from 1 to 2 cc. of alcohol should be injected at the same site. The novocaine injection here acts as a safeguard as to the correct site of injection of alcohol.

Indications for Alcohol Injection. Any patient who, because of his general or mental condition, is judged to be unsuitable for radical surgery, should be given the chance of improvement or even cure by means of paravertebral injections of alcohol. Large numbers of cases are recorded where this type of injection has markedly benefited cases of arterial disease, amputation stump pain, trophic ulcers and the like. It has also been extensively used for the treatment of angina pectoris. The reported risks are very small.

TECHNIQUE

A. *In the Lumbar Region* (see fig. 1805). A hollow needle of sufficient length is introduced 7 centimetres from the mid-line of the back, opposite the first lumbar spinous process, immediately under the last rib, at an angle of 45 degrees to the sagittal plane. It is advanced until the side of the body of the vertebra is impinged upon, then withdrawn a trifle, and again advanced with the point directed slightly more anteriorly, until eventually it slides over the front of the body of the vertebra. As the point of the needle slips over the antero-lateral aspect of the body of the vertebra, it is lying in direct contact with the lumbar sympathetic chain. Having ascertained by suction that the needle is not in a large vessel, a few minims of novocaine are injected. Tests of sympathetic response confirm the position of the needle, and the alcohol injection is then made.

B. *In the Thoracic Region.* One aims at infiltrating the sympathetic rami as they pass to and from the intercostal nerves in the

(2) Chronic Ulcers. Varicose ulcers respond well after a local peri-arterial sympathectomy, combined with treatment to the veins and continuous firm pressure to the ulcer.

(3) Trophic Ulcers. Following a peri-arterial sympathectomy a trophic ulcer may heal in four to five weeks, and remain healed, even though the temporary benefit of circulation often passes off after this time.

(4) Kraurosis Vulvæ. We have already pointed out that the sympathetic nerve fibres causing trophic change in the vulva run with the internal iliac arteries. The site of election for their destruction is therefore a peri-arterial sympathectomy of the internal iliac artery.

(5) Leprosy. In the ulcers of leprosy peri-arterial sympathectomy has been found efficacious, and may promote healing after spontaneous amputations.

RESECTION OF THE PRESACRAL NERVE—PRESACRAL NEURECTOMY, OR COTTÉ'S OPERATION

Position. The patient is placed in a high Trendelenburg position, and the most satisfactory incision is the right paramedian para-umbilical, the centre of the incision being at or just below the level of the umbilicus. After the abdomen is opened, and its contents carefully examined, and any pathological lesion dealt with, the bowel is carefully packed off in an upward and left lateral direction. Cotté's three points

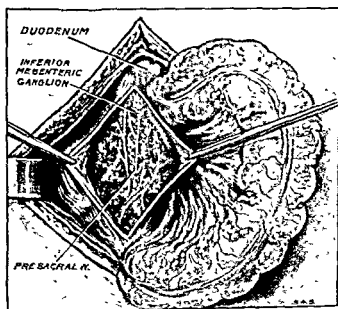


Fig. 1807.—OPERATIVE EXPOSURE OF PRESACRAL NERVE AND
INFERIOR MESENTERIC GANGLION.

region of the intervertebral foramina, and also the sympathetic ganglia. It is usually followed by a short temporary intercostal neuritis. (For technique see fig. 1806.)

COMPLICATIONS AND DISADVANTAGES

Paravertebral alcohol injection is undoubtedly more uncertain than radical surgical sympathectomy, but it saves a major operation, and in bad risk cases is well worth attempting. Local neuritis may be a distressing sequel for a short time. A more serious complication is a Brown-Séquard syndrome, which has followed paravertebral thoracic injection, where the alcohol has leaked into the spinal canal.

Alcohol Injections of Sensory Nerves of Leg and Foot. Injections of alcohol into the sensory nerves at the junction of the middle and lower thirds of the calf have been found to relieve pain, to cause ulcers to heal, and the foot to become warmer and drier, and to be followed by no paralysis of any consequence. They are indicated where more radical procedures are not advisable.

Simple Section of Sensory Nerves in the same position is of more certain effect, and gives rise to similar relief and vasodilatation.

Alcohol Injection of Perivascular Tissue. This is a simple operation without any shock, and gives good immediate results. Some workers have found it more permanent in effects than peri-arterial sympathectomy. 1 to 2 cc. of 95 per cent alcohol are injected, e.g. into the peri-arterial tissue of the femoral artery in the lower part of Scarpa's triangle.

Peri-arterial Sympathectomy. This operation has now to a very large extent fallen into disuse, but still has a very definite, though limited, place in the treatment of sympathetic disorders. It is never to be advised in Raynaud's disease, nor in thrombo-angitis obliterans, except for pain in very advanced cases. Its chief indications are :

(1) Senile and diabetic gangrene. In advanced cases of these conditions it is often well worth while. The performance of a peri-arterial sympathectomy, with ligation of the veins, may avoid a high amputation, cause the ulcerated toes to heal, and give complete relief from pain, though the increased circulation in the limb may, and probably will, be of a purely temporary nature.

SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM

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should now be identified: the sacral promontory, the bifurcation of the aorta, and the inferior mesenteric artery. In addition to these, it is as well to identify the inner borders of the two common iliac arteries, which, together with a transverse line opposite the sacral promontory, constitute the inter-iliac triangle. The posterior parietal peritoneum in this triangle is picked up, in the mid-line, with forceps and opened vertically. At the upper end of this incision the bifurcation of the abdominal aorta is seen.

The dense connective tissue is carefully dissected from the posterior aspect of the peritoneum, and from the front of the body of the fifth lumbar vertebra and the left common iliac vein. This connective tissue contains the nerve plexus which has usually been seen through the peritoneum before the latter was opened. The dense layer of fascia, including the presacral nerve, should be removed, starting from the sacral promontory below, up to the bifurcation of the aorta above. It is essential that the dissection does not extend too far to the left, nor too far downwards. Otherwise the recurrent parasympathetic fibres to the left colon will be injured (see fig. 1775).

This resection includes about one inch of the nerve plexus, which is quite sufficient, and a wider resection is extremely inadvisable. Hæmostasis is easily achieved by pressure, and only occasionally is there any need to pick up and clamp individual vessels. The posterior parietal peritoneum is closed, using continuous fine catgut, and the anterior abdominal wound closed in layers.

TECHNIQUE OF THE OPERATION OF ADRENAL DENERVATION

The position of the patient and the incision are similar to those used for removal of the lumbar ganglion from the loin. In other words, similar to an ordinary renal exposure incision. The kidney is freed from its bed, and drawn downwards, exposing the suprarenal gland at its upper pole. Exposure is easier if the patient is ten or fifteen degrees in the anti-Trendelenburg position. When the gland is separated from its loose connective tissue, from thirty to forty fine nerve filaments are seen running to it. Great care is taken not to damage the blood supply, which is easily distinguished from the nerve fibres. A small retractor, shaped like a hand, rather like a Chinese back-scratcher, is used to hold the gland still, and each nerve is snipped through with long Mayo scissors. Little or no hæmorrhage is found to occur, but a small rubber drain is best left *in situ* for twenty-four hours. The wound is closed layer by layer.

PART XIII
ADRENAL GLAND

SECTION 1
THE SURGERY OF THE ADRENAL GLAND
by
L. R. BROSTER

SECTION 2
SURGICAL PATHOLOGY OF THE ADRENAL
GLAND
by
H. W. C. VINES

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SECTION 1

THE SURGERY OF THE ADRENAL GLAND

by

L. R. BROSTER

"You should be women,
And yet your beards forbid me to interpret
That you are so."

MACBETH.

THAT the adrenal gland has so long remained immune from surgical attack has been influenced mainly by considerations other than those inherent in the gland itself. In the first place, our knowledge of its function in human economy is very limited. It is true that physiologists have extracted the highly important blood-pressure raising principle—adrenalin—from its medulla, and that clinicians have correlated changes in sex characters with lesions of the cortex; but from the surgical aspect, apart from tumour, there has hitherto been no interference. From the security of its deep situation and absence of pressure effects, diagnosis is made difficult, with the result that the sporadic references to its removal have been discouraging, in that surgeons have been called upon to remove highly malignant tumours in a late stage of their evolution. This attitude of *laissez-faire* is all the more surprising when it is considered what a powerful research weapon surgery has proved to be in the elucidation of the problems connected with the remaining glands of the endocrine series. Its success has been marked by ablation operations on those glands where the normal or perverted secretion has been in excess. Biochemistry has been successful in replacing some of these secretions when they have been deficient. Clinical science has learned what powerful influences these glands exercise either individually or collectively, and that altered secretions of one may upset the balance and cause derangement in the functions of others. Deficient secretion of the adrenal cortex causes

OF CASES

OUTLOOK	GENITALIA	CLITORIS	FUCHSIN REACTION	RESULT
Normal	Uterus infantile	+++	Left strong	Very slight change. Abroad.
Indifferent	Uterus infantile Cystic ovaries	++++	Left strong	Very slight change. See figs. 1818, 1809, 1810 and 1817.
Childish	Uterus infantile Cystic ovaries	+	Right strong	Loss of hair. No change. See figs. 1811 and 1816.
Normal	Uterus small	Normal	Left strong	Good result. Loss of hair. Periods regular. Married, has a son since operation. See fig. 1812.
Normal	Uterus small Cystic ovaries	+	Left strong	Menses regular. Hair less, coming out. Headaches less severe. Friends remarked on improve- ment. More feminine. See fig. 1811, A and B.
Normal	Uterus small Cystic ovaries	+	Left strong	Good. Periods fairly regular. Hair not coming out so easily as at first. More interested in life. See fig. 1818.
Normal	Uterus infantile Cystic left ovary	Normal	Right strong	Hair less. Comes out easily Periods regular. Happier. Good.
Homo- sexual	Uterus infantile Cystic ovaries	+	Left Mod.	Not much change. Bedridden before and after operation. Has had 4 periods since.
Normal	Uterus infantile Cystic ovaries	+	Right Mod.	Hair comes out easily. Periods regular. Outlook improved and changed to normal.
Indifferent	Uterus infantile Cystic ovaries	Normal	Right strong	Hair comes out easily. Periods now regular. More feminine in outlook.
Normal	Uterus small Fibrous ovaries	+	Left fairly marked	Good. Hairs white at ends, pull out easily. Periods regular. Com- plexion improved See fig 1813
Male tendencies	Uterus small Big cystic ovaries	+	Left strong	Amenorrhœa continues. Brighter outlook. Much the same. Fair.
Normal	Small fibroid in uterus, small cystic ovaries	++	Left fairly marked	Period started 2 days after operation. Hair all out in 2 weeks.
Homo- sexual	Uterus infantile Cystic ovaries		Left mod.	Hair coming out. Periods regular. Outlook brighter and more normal.
Disgusted with herself. Sensitive	Remaining left ovary cystic	++	Left mod.	Hair all out in 2 weeks. Slight growth on head.

SUMMARY

NO	GROUP	CASE	AGE	DATE	DEGREE OF		PERIODS	VOICE	BREASTS
					VIRIL.	HAIR			
(1)	I	N.G	15	9.27	+++	Marked	Primary amenorrhœa	Low	Under-developed
(2)	I	L.M.	22	9.28	++++	Marked	Primary amenorrhœa	Rough	None
(3)	III	E.N	18	10.30	+	Slight	Amenorrhœa 18 months	Normal	Normal
(4)	II	A.S. x	21	6.29	++	Moderate	Amenorrhœa 10 months	Deep	Small
(5)	II	H.S	22	10.30	+++	Marked	Irregular	Rough	Smaller
(6)	II	G.W	20	7.31	++	Moderate	Amenorrhœa 1 year	Normal	Small
(7)	II	E.C.	21	3.32	++	Moderate	Regular	Normal	Normal
(8)	II	C.S.	29	6.32	+	Very marked	Amenorrhœa 9 months	Normal	Smaller
(9)	II	E.M.	20	7.32	++	Moderate	Irreg. Amen. at times	Harsh	Normal
(10)	II	G.D	18	8.32	++	Moderate	Late onset Irreg.	Normal	Grew with menses
(11)	II	M.H.	30	4.33	+++	Marked	Regular	Deep	Smallish
(12)	II	M.G.	35	5.33	++	Fairly marked	Amenorrhœa at 26	Deep	Smaller
(13)	II	E.G. y	32	11.33	++	Marked	Regular Ceased 26		Small
(14)	II	R.M.	26	8.33	++	Fairly marked	Irreg. Ceased 20		Smallish
(15)	IV	M.C. y	51	10.33	+	Marked Bald	Hyst. R. Ovariect. 38	Roughish	Normal

x = married since operation y = married.

OF CASES

OUTLOOK	GENITALIA	CLITORIS	FUCHSIN REACTION	RESULT
Normal	Uterus infantile	+++	Left strong	Very slight change. Abroad.
Indifferent	Uterus infantile Cystic ovaries	++++	Left strong	Very slight change. See figs. 1808, 1809, 1810 and 1817.
Childish	Uterus infantile Cystic ovaries	+	Right strong	Loss of hair. No change. See figs. 1814 and 1816.
Normal	Uterus small	Normal	Left strong	Good result. Loss of hair. Periods regular. Married, has a son since operation. See fig. 1812.
Normal	Uterus small Cystic ovaries	+	Left strong	Menses regular. Hair less, coming out. Headaches less severe. Friends remarked on improvement. More feminine. See fig. 1811, A and B.
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Homo-sexual	Uterus infantile Cystic ovaries	+	Left Mod.	Not much change. Bedridden before and after operation. Has had 4 periods since.
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Male tendencies	Uterus small Big cystic ovaries	+	Left strong	Amenorrhoea continues. Brighter outlook. Much the same. Fair.
Normal	Small fibroid in uterus, small cystic ovaries	++	Left fairly marked	Period started 2 days after operation. Hair all out in 2 weeks.
Homo-sexual	Uterus infantile Cystic ovaries		Left mod.	Hair coming out. Periods regular. Outlook brighter and more normal.
Disgusted with herself Sensitive	Remaining left ovary cystic	++	Left mod.	Hair all out in 2 weeks. Slight growth on head.

Addison's disease ; the exact role played by the cortex in producing changes in sex characters has yet to be determined, but it has afforded the surgeon an excellent *point d'appui*, and the work on this subject forms the basis of the present article.

Historical. The association of the secondary male sex characters in the female has long been known (1). This association of virilism and hirsutism in females with lesions of the adrenal cortex has now become well established under the designation of the *adreno-genital syndrome*. It is remarkable what advances have been made since 1905, when Bulloch and Sequeira (2) first brought into prominence the association of cortical tumours of the adrenal with precocious appearance of secondary sex characters by a collection of eleven cases, all in children under the age of fifteen years. There are many cases on record in the literature of the adreno-genital syndrome due to tumours, but fewer of their successful removal, the most notable of these being the case published by Gordon Holmes of the successful removal of a cortical adenoma by Sargent (3). Less attention, however, has been paid to the form associated with cortical hyperplasia (4), and hitherto this lesion has only been demonstrated in the post-mortem room, and until recently there appear to be no records in the literature of the effects of operative interference in the adreno-genital syndrome due to this condition.

THE ADRENO-GENITAL SYNDROME

This syndrome may be defined as that condition in which secondary male sex characters appear in the female, and is associated with a retrogression of the primary and secondary feminine sex characters and their functions. The clinical picture is determined by the type of lesion and the age of the patient. Hyperplasia, owing to its slow growth, is not likely to produce such rapid changes in the sexual sphere as malignant tumours, which are usually rapidly fatal, whilst the course of benign adenomata is intermediate between the two. The age of the individual when the adrenal condition develops also plays an important part. As can be readily understood, the effects of the lesion will vary according to whether the organism at the time of onset is immature or fully developed.

Symptomatology.

1. The appearance and disappearance in the female of hair according to the male pattern and distribution.

2. Alterations in bodily contour towards the male sphere :

- (a) Overgrowth of skeletal structures such as muscle and bone ; lessening of the subcutaneous fat, and coarsening in the texture of the skin.
- (b) Broadening of the shoulder relative to the pelvic girdle.
- (c) Enlargement of the clitoris.
- (d) Deepening of the voice.

3. Immature development of the female genitalia, both external and internal ; the ovaries are degenerate, giving rise to amenorrhœa, either primary or secondary, and disturbances of menstruation. There may be absence or under-development of the breasts.

4. Alterations in psychological outlook towards the male sphere.

Hypertrichosis. Male hair in the female varies in texture and distribution. It ranges from the curly crisp variety to the soft downy type, which is patchy. On the face it may take the form of a beard and moustache, or that of " mutton chop " whiskers. On the trunk the hairs extend triangularly to the umbilicus from the pubes ; they may cover the mid-sternal or lumbo-sacral regions, the shoulders, or form a halo round the nipples. The perineum and axillæ are more densely covered. On the limbs they grow thickest over the thighs, or on the legs and forearms, and the male mimicry may be complete to tufts of hair on the dorsum of the feet or proximal phalanges. In older women baldness and temporal recession may be conspicuous.

Changes in Bodily Contour. The bodily contour varies with the time of onset and degree of virilism. The early cases are more masculine in appearance than under-developed boys. They are short, thick-set, broad-shouldered, deep-chested, narrow-hipped, and the muscles of their limbs stand out prominently under a layer of coarse skin with little subcutaneous fat. When feminine growth has been established no such marked alteration can take place, but there is usually some indication of variation, such as a lessened disproportion between the relative breadth of the pectoral and pelvic girdles, a tendency to " heftiness," and an undue hint of prominence of the superciliary ridge or the jaw, especially radiologically.

The breasts on the whole are under-developed. There may be a complete absence of both breasts, some never developing fully, while others mature and then retrogress ; when large they are composed of much fatty tissue. Microscopic section of some breast tissue removed for



(front view)

Fig. 1811a.—ADRENAL VIRILISM.
MASCULINE MUSCULAR BUILD.
SMALL BREASTS.
(Br. Jl. Surg.)



(back view)

Fig. 1811b.—MALE DISTRIBUTION
OF HAIR ON ABDOMEN, CHEST,
SHOULDERS AND SACRUM. - -
(Br. Jl. Surg.)



Fig. 1812.—"MUTTON CHOP WHISKERS."
GAVE BIRTH TO A SON AFTER ADRENAL
ECTOMY.



Fig. 1813—MASCULINE TYPE. MARKED HIRSVTISM.
(The Lancet.)

Adrenal Pseudo-hermaphroditism. The most complete form of the syndrome, where changes occur before the bodily form and sex organs have become differentiated. There was marked virilism and hypertrichosis of the male type with primary amenorrhœa, and normal feminine development had not taken place (figs. 1808, 1809 and 1810).

Adrenal Virilism. A later variety, where the adrenal changes set in after puberty, is associated with alterations in the bodily form, and in the external sex organs, hypertrichosis of the male type, and a disturbance of sex function. Owing to the later development of the adrenal lesion, the normal bodily changes of puberty, and a period of normal menstruation, were followed by regressive changes in both spheres, bodily changes towards masculinity, a diminution in the size of the breasts, and a diminution in the menstrual flow (figs. 1811A, 1811B, 1812 and 1813).

The Achard-Thiers Syndrome. Here the adrenal lesion appears to be one element in a multiglandular syndrome. These patients presented the symptom-complex described by Achard and Thiers (6) as "diabetes of bearded women," a condition, found at autopsy, of adrenal hyperplasia associated with changes in other ductless glands. The chief symptoms were hypertrichosis on the face of the male type, obesity, glycosuria with decreased carbohydrate tolerance, hypertension, and usually amenorrhœa, but without other signs of virilism.

With regard to the groups where virilism occurs after puberty, it is worthy of note that the onset is very similar, but there may be at this stage signs of other endocrine imbalance. In Group II some of these individuals become fat, but the majority lose this fat and remain adrenal in type, while others who retain it drift off into multiglandular types. In Group III the onset of virilism is followed by an adiposity which becomes permanent. In one case of Group III (fig. 1814) submitted to unilateral adrenalectomy—previously published—Dr. Gardiner-Hill considered that the adrenal formed part of a multiglandular syndrome, but now he has inclined to the view that she is probably a case of Cushing's basophil adenoma of the pituitary. There



Fig. 1814.—CUSHING'S SYNDROME.
(Br. J. Surg.)

is a similarity between Group III and Cushing's syndrome (7) (figs. 1815A, B, C, and D). Where the one begins and the other ends is as yet uncertain, but it is suggested that the adrenal factor ushers in an imbalance which in certain cases shifts more and more to the latter type.

PRE-OPERATIVE INVESTIGATIONS

Laboratory investigations have given mainly negative results, but with rare material of this kind it is essential that every case should be fully investigated. In this series the blood calcium, phosphorus, cholesterol, urea, and sugar, the gastric acidity, the sugar tolerance curve, and the effect of insulin on the fasting patient have been investigated. This last experiment was designed to see what resistance these patients had to insulin. They were all within normal limits. The sugar tolerance curves in the majority of cases showed some distortion from the strictly normal response, in that there was a normal elevation from the fasting stage, but a slower return to normal. The insulin test was generally unsatisfactory from the point of view of drawing any conclusions, but there was a tendency to show a resistance to insulin. In Group III the results showed a raised cholesterol blood content, and a high sugar tolerance (see fig. 1814) curve as compared with the others. In this Group, too, there was a definite tendency to show an increase in the red cell count.

A routine X-ray of the sella should be carried out. The pituitary fossa is invariably a small one.

A uroselectan X-ray should also be carried out. In this way it may be possible to detect an adrenal tumour, either by distortion or relative displacement of the renal pelvis on one side.

In spite of this information the only reliable method is direct palpation by means of an exploratory laparotomy. The relative sizes of the adrenal glands can be estimated, a search made for accessory adrenals, and any changes in the uterus and ovaries can be detected.

OPERATIVE RESULTS

All the cases submitted to unilateral adrenalectomy have shown no untoward sign so far as their general physical condition and well-being are concerned. It is perhaps too early to speak of the ultimate value of the operation, and no hard-and-fast rules can as yet be laid down with regard to the selection of cases. As a generalisation it may be said that there has been a definite tendency towards the restoration



Fig. 1815C.—CASE OF CUSHING'S SYNDROME. TO SHOW CHANGES BETWEEN AGES OF 15-19. NORMAL TILL 15. HIRUTISM, 16. PERIOD COMMENCED, 12. PERIOD IRREGULAR AFTER 15. PERIOD CEASED, 18. BEGAN TO PUT ON WEIGHT, 15-16. (H.P. 150/100.)



Fig. 1815B.—CASE OF CUSHING'S SYNDROME.



Fig. 1815C.—CASE OF CUSHING'S SYNDROME.



Fig. 1815D.—CASE OF CUSHING'S SYNDROME.

of the menstrual function, and in obstinate cases the injection of oestrin has been useful. Another striking effect immediately after operation is that of painless depilation, and bunches of acquired hair can be pulled out with little or no pain. These hairs grow again, but gradually lose their virile character, and tend to become thin, attenuated, and sparser. In a few cases there have been slight colour changes.

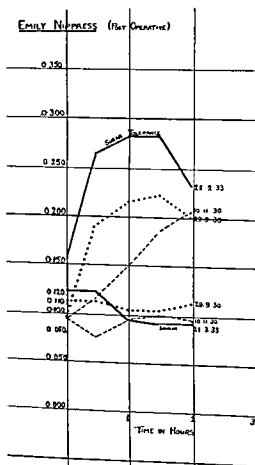


Fig. 1816 (BELONGING TO CASE (3)).—SUGAR TOLERANCE CURVES BEFORE, IMMEDIATELY AFTER, AND 2½ YEARS AFTER OPERATION. THE LOWER CURVES REPRESENT SUGAR TOLERANCE CURVES AFTER ADMINISTRATION OF 10 UNITS OF INSULIN. (*The Lancet*.)

of the adrenals, unilateral adrenalectomy has not been performed. The largest adrenal was Case (2) (L.M.), 7.5×7.5 cms., and one of the smallest was in Case (6) (G.W.), $4 \times 2.1 \times 1.5$ cms., and weighing 3.3 gms. The latter is within the limits of normal, but gave the most intensely positive fuchsinophil reaction. These findings suggest that virilism does not necessarily depend on hypertrophy alone, but may be associated with an apparently normal adrenal.

That any dramatic change can take place is not to be expected. So far only that adrenal has been removed which, on palpation at laparotomy, has been considered to be the larger. As adrenals have been removed from either side of the body and have given a positive fuchsinophil reaction, it is natural to infer that they are both affected. If this is not so, then the good results are merely a matter of luck in having removed the only affected adrenal. So far the left has been removed more often than the right. It must be remembered that the remaining adrenal may hypertrophy in the same way that surgical removal of one kidney causes hypertrophy of the other, or removal of half the thyroid may be followed by an enlargement of the other side. Where laparotomy has shown no marked difference in the size

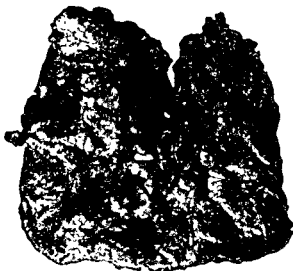


Fig. 1817.—THE LARGEST ADRENAL REMOVED IN THE SERIES. REMOVED FROM CASE (2) OF SUMMARY (SEE FIG. 1808). STRONG FUCHSINOPIHL REACTION. (*Br. Jl. Surg.*)

Encouraging results have only been obtained in cases of post-pubertal virilism, Group II. In pre-pubertal virilism, Group I, they have been disappointing, but this is to be expected, for an operation during the second decade is a late one for a condition which only manifests itself at puberty, and has probably been present for some considerable time. At present there is no method of determining adrenal dysfunction before puberty. If this were possible, then earlier operation should have equally good results. Time must of necessity be the final judge of a speculative surgical procedure. A condition of slow or late development can only be expected to retrogress slowly, where only part of its cause has been removed.



Fig. 1818.—THE SMALLEST ADRENAL REMOVED IN THE SERIES. CASE (6) OF SUMMARY. THE MOST MARKED FUCHSINOPIHL REACTION OF ALL.

SURGICAL APPROACH

The trans-thoracic route has been used in the majority of these cases, under gas and oxygen anaesthesia. This is the easiest approach, in view of the fact that the adrenal vascular pedicle allows a slight range of upward movement and the excursions of the diaphragm are better controlled by incision and retraction. It has the disadvantage of creating an artificial pneumothorax, with its concomitant respiratory distress. Artificial pneumothorax may be induced prior to operation, but as it does not obviate the main issue it cannot be said that it affords any greater advantages. To overcome these difficulties a sub-diaphragmatic route has now been attempted, by fracturing the last rib at its neck and retracting this upwards with the diaphragm. This exposure is not so satisfactory, and the delivery of an adrenal may be impeded by sudden diaphragmatic movements which can only be controlled by expert anaesthesia. Inaccessibility, deep bleeding, and delicate traction on a friable organ through what may be a spasmodically contracting and confined space, are the main difficulties of the operation.

CLINICAL AND PATHOLOGICAL COMPARISON

The most definite conclusions from our observations point to the advent of male characters in the female associated with menstrual irregularity, and correlated with this are the microscopical disclosures of a constant staining reaction in the adrenal cortex with a degenerative ovarian condition. Clinically, the suppression of the menstrual function invariably occurs at the time of, or soon after the onset of virilism, and in our series constantly during the second decade. The average time factors are as follows :

Average age of patients—20 years.

Average age of start of menstruation—14 years.

Average age of onset of virilism—15 years.

Average age for increase in weight—16 years.

Average age of menstrual irregularity—18 to 20 years.

Theoretical considerations. The pathological interpretation of this sequence of events is difficult. It may be argued that :

1. There is a state of normal antagonism between the ovary and adrenal, and where the ovarian function fails, the adrenal is left to exert a riotous influence. This, however, does not explain why an

ovarian function should fail at the springtide of its development, for when it does so naturally at the menopause, or artificially after double ovariectomy, virilism is not a constant or a marked feature.

2. Or conversely, that the adrenal cortex possesses a "male factor," which, when present in sufficient potency, is able to suppress or inhibit the ovarian function.

3. Or possibly, that this period of imbalance between the ovary and adrenal is associated with a failure on the part of the pituitary (anterior lobe). The adiposity and amenorrhœa may be explained on such grounds. This is supported pathologically by the findings of two fuchsinophil foetal adrenals associated with pituitary hyperplasia. Periodic headache, so marked a feature in some clinical histories, may be the expression of a pituitary hyperplasia, taking place within the narrow confines of the sella turcica.

APPLIED HISTOLOGY

With this range of clinical material it was possible to argue that if there was no cause to be found in the arrangement or shape of the cortical cells, there might possibly be a difference in function. By using the Ponceau fuchsin stain Dr. Vines (4) was able to show that in a series of cases of unilateral adrenalectomy for virilism the cytoplasm of the cells of the cortex contained a vivid red granular material, mainly in the inner and middle zones (*frontispiece A*). This colour varied in intensity, and was most vivid in an adrenal which in size was within normal limits, suggesting that the response was as much qualitative as it was quantitative in the case of hyperplasia.

To exclude the possibility of post-mortem changes taking place in the adrenal, a control series was started by removing portions of normal adrenal in the course of performing kidney operations (*frontispiece B*). These were all negative to the stain as were all normal post-mortem adrenals. A collection of several autopsy specimens of adrenal tumour associated with virilism gave a positive reaction, showing that the fuchsinophil material in the cells is capable of surviving post-mortem conditions. It seemed unlikely that some isolated reaction had been obtained in the adult, so a further search was made into foetal adrenals. Dr. Vines found a strong fuchsinophil reaction in the male foetus between the ninth and seventeenth week (*frontispiece C*). In the female foetus the reaction was not so strong, and of shorter duration, lasting from the eleventh to the fourteenth week (*frontispiece D*). After the twentieth week it was absent in both sexes. This observation may well

prove to be one of fundamental importance in the elucidation of many difficulties. It establishes a very early and passing phase in embryology, common to both sexes, but less marked and of shorter duration in the female.

In other tissues of the body traces of this reaction were found in the interstitial cells of the testis, the corpus luteum, and the anterior lobe of the pituitary.

APPLIED EMBRYOLOGY

In point of time the cells of the adrenal cortex can be recognised about the fourth week, and are derived from the same mass of cells, the genital ridge—which also give rise to either the testis or ovary. There is thus a common origin for the cortex and sex gland. The determination of sex takes place about the seventh week and, as we have noted, the appearance of the fuchsinophil reaction commences some two to four weeks later.

Our clinical evidence and operative results have established a very marked connection between this reaction and a condition of maleness in the female, and this naturally suggested the possibility that "the substance so staining must be closely related to or even identical with the male hormone or its precursor," and its presence in the intercellular spaces further suggested that it acts via the blood stream.

Crew (8) states that: "So far as is known, the sex chromosome mechanism is the sex determining mechanism, but in many cases this mechanism can be overridden and the sex of the individual determined in other ways." It is therefore reasonable to argue that a strong and prolonged male phase in the female foetus may possibly be one of those factors which so determine sex. To what extent is still a matter of conjecture. A positive reaction has been found in a case of true hermaphroditism, and it is probable that sex reversal, from female to male, will come to be included in this category. But it is known that the cells of the adrenal cortex still retain the power of developing this substance into adult life, and that it may become activated at certain periods of physiological stress, such as puberty. If this explanation is accepted then it readily accounts for Groups I and II, which have already been considered clinically.

However, in Group III the problem is not so simple. It may be argued that in adult virilism there is a failure on the part of some feminising influence to counteract the male phase. The brief duration of this male phase in the female foetus suggests that it is suppressed, and this suppression is due to some mechanism dependent on the

functional activity of the other endocrine organs. That there is some such mechanism was found by Dr. Vines in two female foetuses, in which a prolonged male phase was accompanied by a definite hyperplasia of the pituitary. Hence, virilism may be due to a failure to maintain the normal balance between the anterior lobe of the pituitary and the male adrenal. This type would be associated with a pituitary dysfunction, the clinical picture being determined by the predominance of one or the other factor, and when the pituitary dysfunction is in the ascendant there is a shift towards the type of basophil syndrome of the pituitary described by Cushing.

COMPARATIVE ANATOMY OF THE ADRENAL GLAND

In order to obtain a clear conception of the background of our work, it is necessary to refer briefly to the comparative anatomy of the adrenal, and to trace the steps which have led to the formation of this highly specialised organ.

In its primitive form the cortex is separate and intimately connected with the reproductive system. It then becomes associated with the cells of quite a different system—the sympathetic—which ultimately forms the medulla. It appears first in fish, and increases in importance, so that the glands become essential to life in the higher animals. In sharks and rays the two cell systems are separate. The cortex is known as the *inter-renal* body and is associated with a marked development of the sexual system. In amphibians (frogs) the two cell systems make a definite advance towards each other, and are arranged in a chain along the lumbar segments, until we find them intimately mixed in reptiles and birds to form a solid organ. In mammals and man the medulla becomes completely enclosed with the cortex, and the method by which these sympathetic cells wander into the cortex in man has not been observed even in the higher apes. From the nature of such a migratory process it is not uncommon for cells to become detached, and to form accessory adrenals, which may contain the elements of one or the other, or of both these cell systems. In man the adrenals reach the maximum size of their development at birth, when each is about one-third the size of the kidney. The cortex then undergoes an astonishing and rapid process of absorption and regeneration until the size of the gland is reduced to one-thirtieth of that of the kidney. The glands enlarge at puberty, during pregnancy, and at the menses. Between the fourth and fifth decade they reach their zenith and then gradually undergo a senile involution. It occasionally happens that this adult

stage of the gland is present at birth, and is then associated with anencephaly, so that it has been thought that the cortex is in some way connected with the development of tissues rich in lecithin.

CLINICAL SUMMARY

From an examination of some sixty cases with virilism of varying degree, a few general conclusions may be discussed. That heredity plays a part there is no doubt. A family history of hirsutism was present in 25 per cent, and in these it was twice as common on the distaff side. On the male side it ranged from grandfather, father, to brothers; on the female, from mother, sisters, aunts, daughters, and nieces—more frequent in aunts and sisters. It thus appears to be transmitted more on the female side. There is slight evidence that it is associated with the events which occur at birth. It occurred in two cases of twin births, one case of premature birth, and in one case it appeared in the four-year-old daughter, within three months of its onset in the mother. With regard to other endocrine disturbances, it appeared in two cases whose mothers suffered from Graves' disease, in one from whose mother I removed a parenchymatous goitre, and in one whose mother suffered from diabetes. In one case of mild virilism there were symptoms of hyperthyroidism. One point of practical importance must be stressed, and that is that women with virilism are comparatively infertile, as one would expect from the nature of the pathology. If they conceive, they are apt to miscarry. On the other side, one case of unilateral adrenalectomy with amenorrhœa has since married and produced a son.

CONCLUSIONS

1. A further series of twelve cases, in addition to the three previously published, is submitted on the effects of unilateral adrenalectomy in cases of the adreno-genital syndrome. All these cases have made complete recoveries and their general health has been in no way affected.

2. A differential stain has been found which has given positive results in all fifteen cases, and in such cases of tumour giving rise to virilism as we have been able to collect.

3. Hyperplasia is not an essential feature in the production of this syndrome. An apparently normal adrenal cortex, provided it is positive to the stain, can bring about the same result.

4. The same positive staining reaction has been obtained in the cortex of an adrenal removed for what may possibly be considered a case of Cushing's syndrome.

5. The same positive reaction has been obtained in the foetal adrenal of both sexes.

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SECTION 2

SURGICAL PATHOLOGY OF THE ADRENAL GLAND

by

H. W. C. VINES

THE adrenal glands, like the pituitary, are organs of double structure, the two parts, cortex and medulla, taking origin from separate embryonic tissues. The cortex, or foetal inter-renal gland, arises from a small zone of the mesothelium immediately above and in close relation to the Wolffian body from which the kidney and the genital glands also arise, while above it lies the anlage of the liver. These relationships are of importance in that they account for the presence of cortical cell rests in the liver, kidney, and genital structures. In man, as in all other vertebrates, the cortical mass of the adrenal becomes differentiated before the sex of the gonad is recognisable, though the anlage of the latter is present in the indifferent form as the Wolffian body. The cortical cells may be recognised by the fourth week of development in the human foetus, but the differentiation of the gonads occurs later, the male about the sixth week and the female later still at the seventh or eighth week. Herein perhaps may be found some clue to the origins of hermaphrodism and of the intersex type. Evidence of activity of the cortical cells, as demonstrated by the presence of fatty granules in their cytoplasm, is seen early in the second month of foetal development.

The medullary cells, known also as the chromaffine or phæochrome cells, arise, on the other hand, from the ganglionic crest, the anlage of the sympathetic ganglion cells, and they become widely distributed throughout the sympathetic system. The common cell of origin is the undifferentiated neuroblast or sympathogonium of Poll, which becomes differentiated on the one hand into sympathicoblasts maturing to sympathetic neurons, or on the other into phæochromoblasts which develop into phæochromocytes or chromaffine cells. The phæochromoblasts appear first in relation to the pre-aortic plexus of the abdominal cavity and separate into a cervical and an abdominal group,

the latter forming the origin of the adrenal medulla. About the sixth week, immigration of these cells occurs into the cortical cell mass (fig. 1819). At this stage the medullary cells do not show the characteristic chromaffine reaction with bichromates for this does not develop until relatively late, in the fourth month of foetal development.

The development of the adrenal gland does not become complete until the second year of post-natal life, for just before birth a series of remarkable changes occurs, which have been described by Aschoff and others. The inner zones of the cortical cells undergo fatty degeneration and absorption, being replaced by new cells from the outer rim of the foetal cortex, and the latter are built up in the arrangement characteristic of the adult gland. In this way the organ is gradually reduced in size, for while the foetal gland is about one-third the weight of the kidney, in the adult the gland is less than one twenty-fifth. Occasionally this change occurs prematurely and with too great a rapidity, so that the glands of the foetus are found to be very small and of adult structure. In such cases anencephaly is often also present and may be the result of the adrenal dystrophy.

It has been shown by Cramer that the adrenal medulla is closely concerned, in association with the thyroid, in the regulation of body temperature, and that violent changes in temperature are accompanied by very considerable degrees of vascular congestion of the medullary sinusoids. Such a change occurs at birth when there is a comparatively rapid transition from the intra-uterine to the atmospheric temperature. But owing to the degenerative changes in the cells of the inner layers of the cortex, the medullary congestion may lead to rupture of the ill-supported vessels so that hæmorrhage, usually arising between the medullary and cortical layers, may ensue. A similar accident may occur in the course of acute febrile illnesses in children and less commonly in adults. In the most severe cases bilateral hæmatoma of the adrenals develops and ends fatally. If the hæmorrhage is unilateral, recovery is possible and the hæmorrhage becomes converted into a cyst of the affected gland. Other vascular lesions which may be



Fig. 1819.—FOETAL CORTIX OF TENTH WEEK. ($\times 330$) AN ISLET OF MEDULLARY CELLS IMMIGRATING THROUGH THE CORTIX. THE ROSETTE FORMATION IS WELL SEEN AND MAY BE COMPARED WITH THAT OF A MEDULLARY NEUROBLASTOMA (FIG. 1828).

met with are thrombosis or embolism of the adrenal vessels leading to infarction and, when bilateral, to sudden death from acute adrenal failure.

HYPERPLASIA

From the surgical standpoint, the most important changes in the adrenal glands are those of hyperplasia, either simple or neoplastic. The atrophic changes, whether they are those of simple atrophy or of atrophic destruction of the gland by such processes as tuberculosis, culminate in the medical syndrome of Addison's disease and do not therefore fall within the scope of the present work. In considering such hyperplasias, it is again desirable to follow the developmental order and to separate the cortical from the medullary conditions.

CORTICAL HYPERPLASIA

In their recent work on the adrenal cortex, Broster and Vines have grouped the cortical hyperplasias as follows :

Group 1. Simple Cortical Nodules.

- (i) Nodules formed in foetal life and persisting.
- (ii) Nodules formed in post-natal life by sclerosis.
- (iii) Accessory adrenals.
- (iv) Cortical rests in other organs.

Group 2. Simple Hyperplasias.

- (i) Physiological, as in pregnancy.
- (ii) In association with acute infections.
- (iii) The hyperplasia of middle life.
- (iv) Essential hyperplasia with virilism.

Group 3. Neoplastic Hyperplasia.

- (i) Adenoma.
- (ii) Carcinoma.

In Group 1, the first two classes have little if any surgical importance. The nodules are formed only of cortical cells and occur usually in immediate relation to the cortex of the gland: they are very commonly found and are often multiple. There is no evidence that they give rise to any pathological syndrome, or that they commonly

form the sites of origin of neoplasms. True accessory adrenals, containing both cortical and medullary elements, are very much less common, but would appear to be equally benign. These nodules all appear to undergo the same changes at birth as those which are seen in the main gland, and no evidence has been obtained that they are prone to remain in the foetal state.

Cortical rests in organs distant from the adrenal cortex are perhaps in a different category, since they have become so closely related in the literature with the so-called hypernephromata or Grawitz tumours of the kidney, that the impression has been established that they occur frequently in that organ and are often the origin of malignant tumours. Both these ideas are inaccurate, for statistically true adrenal rests occur in the kidney with considerable rarity, and the modern views of the origin of the renal hypernephromata incline more and more towards regarding them as carcinomata arising from the renal epithelium. Actually, adrenal rests occur most frequently in the under-surface of the liver, according to Neusser and to Holmes in about 90 per cent of bodies. If therefore the renal hypernephroma, a not uncommon tumour, is to be traced back to adrenal rests, it might be expected that similar growths in the liver would be of yet greater frequency; in point of fact they are very rare, though Noyes and Vecchi have reported one or two cases. Next in frequency to the liver, cortical rests are found in the genital tract of both sexes, in the region of the epididymis in the male and in relation to the adnexa of the uterus in the female; here they are seen most commonly in children and their frequency appears to decrease with advancing age. They may also be found in the retroperitoneal tissues of the abdomen, and in these situations scattered and rare adrenal tumours have been reported, though in many cases a complete definition of their cortical origin is a matter of doubt. Rests in the kidney are still less common and are usually confined to their upper poles. On the whole it may be fairly said that cortical rests are common, that they occur most frequently in the liver, and that they rarely form the sites of origin of subsequent tumours.

The simple hyperplasias of Group 2 result in a diffuse enlargement of the adrenal cortex as a whole, which in the last sub-group is associated with the clinical exhibition of a specific endocrine hyperactivity. Enlargement in pregnancy is a well-known fact, though it is usually unaccompanied by any evidence of sexual alteration and may be largely associated with the hypercholesterinaemia and increased lipid metabolism. In acute febrile illnesses in young children a very

striking cortical hyperplasia may occur, so that the gland may reach four or more times its normal size. In a case of acute enteritis in a child of eight weeks, the combined weight of the two glands exceeded sixteen grammes. In middle life again, after the age of forty, it is common to find cortical hyperplasia in either sex, though there does not appear to be any definite syndrome resulting from it. The condition has been described by Lucien and Parisot under the general term of "Surrénalite nodulaire," but the probability that it depends upon a true inflammatory process seems doubtful and the evidence slight. It is characterised by a well-marked hyperplasia, affecting chiefly the two

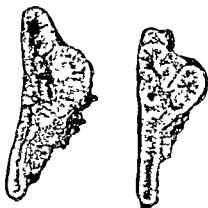


Fig. 1820.—HYPERPLASIA OF MIDDLE LIFE. THE CORTICAL ZONE IS THICKENED AND FOCAL AREAS OF HYPERPLASIA SUGGEST AN ADENOMATOUS FORMATION.
(Charing Cross Hospital Museum)



Fig. 1821.—HYPERPLASIA OF MIDDLE LIFE. A CORTICAL ADENOMA, THE RESULT OF FOCAL HYPERPLASIA.
(Charing Cross Hospital Museum.)

inner zones of the cortex, and patchy lymphocytic infiltration may sometimes be seen, usually, however, disposed in relation to the large vessels in the medulla. A striking feature in many of these cases is a multicentric focal hyperplasia (figs. 1820 and 1821), causing the appearance of miliary cortical adenomatous masses, one of which may sometimes reach the size of a walnut in individual instances. Tumours of this size are usually unilateral. These adenomatous masses are not at all uncommon if the adrenals are examined as a routine measure in autopsies on the middle-aged. Four were found in a series of 100 autopsies, and of eight cases the average age incidence was sixty years. It seems not improbable that they are not due to inflammation, but that they are comparable to the focal hyperplasias which occur in the thyroid or prostate, again causing the appearance of false adenomata.

In none of the writer's cases were these masses associated with evidence of sexual change.

The essential hyperplasia of the cortex which is accompanied by virilism is the only form of simple enlargement which is associated with a definite clinical syndrome, or which calls for surgical interference to alleviate the symptoms. Since, however, virilism may be met with in relation to neoplastic hyperplasia of the cortex, it will be more suitable to defer the discussion of the adreno-genital syndrome until the neoplastic conditions have been briefly considered.

True adenomata of the cortex, as distinct from the focal hyperplasia referred to, are, like the true adenomata of the thyroid, rare tumours. Since the distinction between focal hyperplasias of middle life and true adenomata does not appear to have been previously made, the cortical adenomata are probably of extreme rarity in reality. The frequency with which areas of simple adenomatous structure may be seen in adeno-carcinoma suggests the possibility that the malignant tumour may arise from a benign precursor, that the latter has a very strong tendency to become malignant, and that it does not maintain its benign characters long enough to form an appreciable mass or to give rise to symptoms.

Hence the cortical carcinomata form the bulk of adrenal neoplasms; they may occur at any age, a point which is further suggestive of a possible adenomatous origin. Their incidence, in the writer's series, falls rather sharply into two age groups: in childhood from infancy to puberty, and in adults in the fifth decade. The tumours are usually of moderate size and show a great tendency to necrosis and hæmorrhage (fig. 1822), and often therefore to the formation of cysts; they may



Fig. 1822.—CORTICAL CARCINOMA. THE GROWTH SHOWS LARGE BLOOD CYSTS, THE RESULT OF NECROSIS.
(Charing Cross Hospital Museum.)

show yellowish fatty areas like the renal hypernephromata. Local invasion of adjacent structures may occur, though the anatomical division between the adrenal tumour and the kidney is often well preserved, the latter becoming distorted and undergoing pressure atrophy. Like the renal carcinomata, there is a strong tendency for these growths to invade and grow along the suprarenal and renal veins, so that pulmonary metastases are common and may arise early. On the other hand, skeletal metastases are not common, a point of difference from the renal tumours. Structurally these growths present two types, the adeno-carcinoma, which is the more common, and the fully-developed

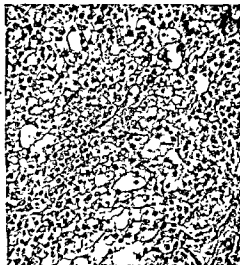


Fig 1823.—CORTICAL ADENO-CARCINOMA ($\times 300$)
THE CELLS ARE WELL-DIFFERENTIATED AND THEIR
ARRANGEMENT RECALLS THAT OF THE NORMAL
CORTIX VIRILISM WAS PRESENT IN THIS CASE, A
WOMAN OF 40.

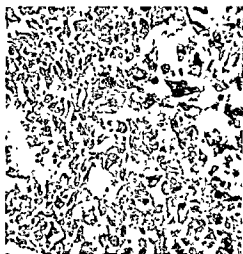


Fig 1824 —FULLY-DEVELOPED CARCINOMA. ($\times 210$)
THE CELLS ARE ATYPICAL AND WITHOUT ANY
ORGANOID ARRANGEMENT; MANY MULTINUCLEAR
CELLS ARE PRESENT. VIRILISM WAS ABSENT.

carcinoma. In the adeno-carcinoma much of the tumour may show an almost simple adenomatous structure (fig. 1823) with a well-developed stroma and well-formed blood-vessels. The tumour cells are larger than normal, often with hyperchromatic nuclei, but their general arrangement is in columns and an organoid structure resembling the normal cortex is maintained. In fully-developed carcinoma (fig. 1824) de-differentiation is more marked; the arrangement of the cells is disorderly and an extreme variation in their size and shape may be met with. Multinuclear giant cells of large size occur and may indeed form a most prominent feature. Occasionally a yet more malignant type is seen, a diffuse carcinoma in which all semblance of organoid arrangement or of the initial cell type is entirely lost, and de-differentiation

may reach such a degree that the similarity of the tumour to a sarcomatous growth is considerable. Some, but by no means all, of the cortical carcinomata may be associated with sexual changes, but the statement that adrenal carcinomata are always accompanied by such changes is inaccurate.

THE ADRENO-GENITAL SYNDROME

While we remain largely ignorant of the more detailed functions of the adrenal cortex, it has long been recognised that it may exert a profound influence upon the development and function of the sex glands. Developmentally, the hermaphrodite or intersex type is ascribed in many cases to errors of cortical function in the foetus, while post-natal masculinisation of the female, the syndrome of virilism, is considered to be due to the same cause. Virilism is seen most commonly about the time of puberty, and between these two periods, the foetal and the pubertal, scattered cases of heterosexual prematurity, indicated by masculinisation of the female child, may be met with, though more commonly homosexual prematurity occurs, either in the male or in the female child. Of these sex disturbances the first group are most commonly associated with adrenal hyperplasias; the second group may be due to a number of different errors of glandular function of which adrenal hyperplasia may rarely be one. In the childhood period sexual changes of adrenal origin are related more frequently to carcinomata than to diffuse hyperplasias of simple type, and the same may be said of those cases of virilism which occur in women about forty years of age. The pubertal virilism of young women, on the other hand, is almost always associated with simple diffuse hyperplasia of the cortex. In general terms, it may perhaps be said that simple hyperfunction of the cortex is involved in the foetal development of certain cases of hermaphroditism, and of the pubertal masculinisation of the female, while hyperfunction of neoplastic origin can result in masculinisation at any time. In regard to this, it is the writer's experience that masculinisation of neoplastic origin is found in the majority of cases in relation to the adeno-carcinomata, and that the fully developed carcinomata do not have any marked effect upon the sexual system.

Masculinisation in the mature female is relatively easy to identify in comparison with the changes which may occur during childhood. After puberty the chief changes are the redistribution of the somatic hair from the female to the male type, followed sooner or later by

amenorrhœa and suppression of ovarian function, indicated by follicular cystic degeneration of the ovary. In the prepubertal female there are other conditions which may lead to confusion. Masculinisation or heterosexual prematurity of the female is the distinguishing feature of the true adreno-genital syndrome, whereas in simple *pubertas præcox* the female child shows a homosexual prematurity which is essentially feminine and is associated with a functional gonad which causes premature menstruation and ovulation, while pregnancy may also occur. Occasionally, however, cases may be met with in which a cortical neoplasm may give rise to a degree of homosexual precocity in young girls, though they are distinctly uncommon. In males, cortical tumours may produce simple *pubertas præcox* of the male type with premature gonadal function, while after puberty no specific changes can be defined. Leyton, Turnbull and Bratton have described two cases of cortical hyperplasia associated with thymic malignancy; in one of these, a boy of eleven years, an accompanying homosexual precocity was present. In the case reported by Harwood, a cortical carcinoma was present in a young boy who showed enlargement of the penis, but no definite sexual precocity; in this case hemi-hypertrophy of the body was also present.

The histological differentiation between simple hyperplasias of the cortex associated with virilism and those which are not accompanied by this syndrome has been unsuccessful until recently, since no constant structural differences have been found, beyond increase in the number of cortical cells. By staining with Ponceau fuchsin and anilin blue, Vines noted that, in the diffuse hyperplasias of virilism, the cortical cells contained in their cytoplasm a large amount of a substance which stained a vivid red; the material was present chiefly in the cells of the *zonæ reticularis* and *fasciculata*, and was absent, or present in much smaller amounts in the cortical cells of normal glands. This fuchsinophil substance was also found in patches in the cells of carcinomata associated with signs of masculinisation, but was absent from growths where these symptoms had not appeared. It was therefore inferred that some relationship might exist between the presence of the fuchsinophil material and the incidence of masculinisation, though no claim could be advanced without biochemical proof that the fuchsinophil material and the masculinising hormone were identical.

The appearance of this fuchsinophil material in the cells of adenocarcinomata associated with masculinisation in young children suggested the possibility that by de-differentiation the tumour cells were repeating some normal phase of secretory activity which occurred early

in foetal life : foetal adrenals were therefore examined by this method. It was found that after the nineteenth week of foetal development, little if any of the fuchsinophil material was present in the cortical cells, while before that period the substance was seen for different periods depending on the sex. In the male a fuchsinophil reaction was obtained from the tenth to the eighteenth week, but in the female only until the fifteenth week.

Attention has already been called to the fact that evidence of some cortical activity, represented by the appearance of granules in the cells, may be seen as early as the second month, and also that the sex glands become recognisable between the sixth and eighth weeks. The fuchsinophil reaction of the cortical cells therefore develops very shortly after the appearance of the sex glands.

Upon the assumption that the fuchsinophil material in the cortex may be correlated with a masculinising activity, it was suggested that the short duration of the fuchsinophil reaction in the female foetus was due to a suppression of the masculinising activity of the cortex, possibly through the intervention of the pituitary ; but it must also follow that the normal female foetus passes through a brief period of "maleness," a male phase. If this normal suppression of the male phase should fail to occur for any reason, the highly plastic female gonad would become affected by a persistent masculinising influence ; it does not seem unreasonable to suppose that a greater or less degree of sexual reversal would ensue, leading to the birth of a child with a degree of hermaphroditism varying from bilateral cryptorchidism with hypospadias on the one hand, to an apparently normal female on the other, who would subsequently develop virilism at puberty. For if this "male phase" of the female foetus is accepted, it is evident that mild degrees of its persistence may be compensated during the early years of life, so that somatic development may proceed normally along feminine lines, a condition of latent virilism. At puberty, however, there is a readjustment of endocrine balance, and it is generally agreed that at this time hidden weaknesses of endocrine function often become manifest ; in the same way a latent virilism may become apparent within a year or two of puberty. In our series of 16 cases of adolescent virilism, the average age of onset of menstruation was 14 years, and of virilism 15 years, showing the close association of the latter with the puberty period. In this way hermaphroditism of adrenal origin may be regarded as the immediate and virilism as the delayed or latent result of a failure of inhibition of the normal male phase of the female foetus.

Masculinisation due to adeno-carcinomata is evidently in a different

category, and is the result of the production of a physiologically active secretion by neoplastic cells which have not become de-differentiated functionally beyond a point at which this specialised process is still possible. Many of these adeno-carcinomata show areas, often of considerable size, in which the structure is almost purely adenomatous, and it is tempting to trace the masculinising function back to the male phase of early foetal life, a stage of comparatively high development.

Of the cause of this hypothetical persistence of the male phase in the female, the evidence is at present slight. In one case in the writer's series, fuchsinophil adrenals were found during foetal development subsequent to the twentieth week, a time when in both sexes the reaction is normally negative. Associated with this the pituitary was very markedly enlarged, but beyond hyperplasia of the cells of the anterior lobe, its structure was not abnormal. The foetus was developed normally as a female, and it is possible that this formed an example of latent masculinisation in which the pituitary, by hyperplasia, was able to maintain the development of a feminine soma. It is not impossible that the initial fault in adrenal hermaphroditism or in virilism is a functional failure of the pituitary to control the adrenal, so that masculinisation occurs as a result of such failure, and the primary error is not one of cortical function at all. Anatomical hyperplasia of the cortex is by no means constantly found in cases of virilism; in several of our cases the size and weight of the adrenal fell well within the normal limits, and it was in such cases that the fuchsinophil reaction was most striking. It must be admitted that the problem of the cortical influence upon sexual development is by no means fully solved as yet, and the possibility that the real error may lie in some gland other than the adrenal should not be too lightly dismissed.

MEDULLARY HYPERPLASIA

Diffuse medullary hyperplasia, comparable to the cortical type, does not form any definite pathological entity; nodular hyperplasia has been reported on various occasions by different authors, probably the result of focal overgrowth. The majority of cases of medullary hyperplasia, at any time a rare condition, fall definitely into the neoplastic category.

The medullary cells are developed from the primitive neuroblasts of the sympathetic anlage, which differentiates either into the sympathetic neuron on the one hand, or into chromaffine cells on the other. Three types of tumour may therefore arise from these precursors; the

chromaffine tumour or paraganglioma, also known as phæochromocytoma; the ganglioneuroma, and the neuroblastoma. Of these, the first two are formed from adult and well differentiated cells, and are therefore generally benign; they occur chiefly in adults. The neuroblastomata, on the contrary, are formed of more primitive cells; they possess a high malignancy and occur very largely in children.

Paragangliomata. Tumours composed of chromaffine cells may arise in a variety of localities such as the sympathetic plexuses, the carotid body, or in relation to the aorta in the region of its bifurcation as remains of the foetal organ of Zuckerkandl; most commonly, however, they occur in the adrenal medulla. Here the tumours are usually small and their cells show a considerable pleomorphism, being round, oval, polygonal, or sometimes spindle-shaped. The chromaffine reaction is irregularly distributed in the tumour cells and is not given by all of them. Vascularity of the growth may be considerable, and though the tumour mass may be sharply differentiated from the rest of the medullary cells, encapsulation is not necessarily complete. These growths are essentially benign and occur after the age of forty, the period when hypertensive changes are prone to become evident. Like the cortical hyperplasias, they may produce a secretion with hypertensive properties so that their presence may result in a raised blood-pressure which may terminate fatally in some vascular accident, in cardiac failure, or in acute pulmonary œdema. Mayo has reported a case in which the rise in blood-pressure was not continuous but was paroxysmal. Surgical removal of these tumours has been successful in a few cases, and has been followed by a complete recovery with disappearance of the hypertensive symptoms. Apart from this particular syndrome, many attempts have been made to correlate conditions of hypertension, either essential or nephritic, with medullary hyperfunction or hyperplasia, but at present no firm basis has been found upon which such an hypothesis can rest.

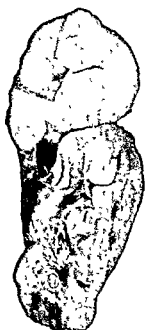


Fig 1825.—ADRENAL GANGLIONEUROMA. A FIRM WHITE TUMOUR OCCUPYING THE POSITION OF THE ADRENAL. NUMEROUS SIMILAR GROWTHS WERE PRESENT IN OTHER LOCALITIES.
(Charing Cross Hospital Museum.)

Ganglioneuromata. These tumours (fig. 1825) are uncommon and are usually benign; they

may occur either in adults or in children, perhaps more often in the latter. They are composed of typical ganglion cells in company with nerve fibres, either medullated or non-medullated, or sometimes with both; glial tissue may also be found together with fibrous tissue and occasionally smooth muscle-fibres have been reported (figs. 1826 and 1827). In a recent case multiple tumours were distributed throughout the tissues of the body forming firm white masses with sharply defined edges; they were seen in lymph glands, testis, pancreas, the subcutaneous tissues of the trunk, and in the adrenal medulla of the left side. In the adrenal tumour, which formed the largest mass, well differentiated ganglion cells, areas of glial tissue,

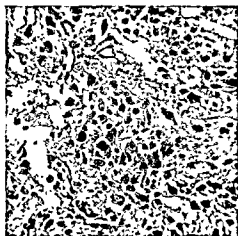


Fig. 1826.—ADRENAL GANGLIONEUROMA. ($\times 290$.)
SHOWING THE PRESENCE OF ATYPICAL GANGLION
CELLS.

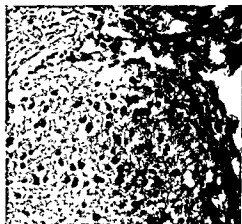


Fig. 1827.—ADRENAL GANGLIONEUROMA. ($\times 350$.)
SHOWING THE PRESENCE OF GLIAL TISSUE IN THE
SAME GROWTH.

and more undifferentiated neuroblastic cells were all seen. The patient was a boy aged 15 months. The condition in this case would be more faithfully described as a neurogangliomatosis derived from some developmental error of the sympathetic nervous system as a whole, than as a primary growth of the adrenal medulla with metastatic spread. The multiplicity of the tumours beneath the skin suggested a neurofibromatosis, and sometimes both ganglioneuroma and paraganglioma may be associated with such a condition.

Neuroblastomata. Other names by which these tumours are known are neurocytoma or sympathicoblastoma. Arising almost entirely in children, and being possessed of a high malignancy, they are composed of deeply-staining oval or round cells of low differentiation which may show a greater or less degree of arrangement in rosettes (fig. 1823),

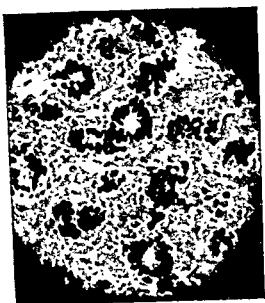


Fig. 1828.—ADRENAL NEUROBLASTOMA. ($\times 630$.)
THE ROSETTE FORMATION OF THE TUMOUR CELLS
IS CLEARLY SEEN.

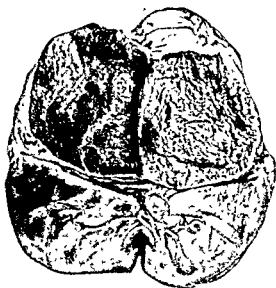


Fig. 1829.—ADRENAL NEUROBLASTOMA. A HÆMORRHAGIC
TUMOUR OF THE LEFT ADRENAL IN A CHILD AGED 3½
MONTHS. SECONDARY DEPOSITS WERE PRESENT IN THE
LIVER. THEORETICALLY THERE SHOULD HAVE BEEN A
HUTCHINSON SYNDROME AS REGARDS THEIR DISTRIBUTION;
ACTUALLY THE LATTER CORRESPONDED TO THE PEPPER
TYPE.

(Charing Cross Hospital Museum.)

similar to that seen in the so-called glioma of the retina. The centres of these rosettes are formed of a felted mass of very fine fibrils. The cell type is rather similar to that of the foetal medulla, and from its undifferentiated characters the growth has often been described as a round-cell- or lympho-sarcoma; it is the form of growth usually found in the "retroperitoneal sarcomata" of children, and these tumours are in the majority of cases almost certainly derived from the sympathetic plexuses. The adrenal tumour may reach a considerable size or may still be small at the time of death, for they are rapidly fatal. A greater or less amount of hæmorrhage is usually present. The most striking feature of these tumours, however, is their extensive metastasis. The different distribution of the secondary deposits, according as to whether the primary growth is in the left or right adrenal, has led to the differentiation of two syndromes, that of Hutchinson and that of Pepper. In the Hutchinson syndrome the left adrenal forms the site of the primary growth and the metastases occur particularly in the bones, especially the ribs and skull, and in the lungs, liver and other organs to a less extent. An orbital tumour of the left side with ecchymosis and exophthalmos may be the first indication of the disease. In the Pepper syndrome (figs. 1829 and 1830) when the right adrenal is affected primarily, the metastases are largely limited to the liver, in which

hæmorrhagic masses are seen and infiltration may be so extensive that hardly any normal liver tissue can be recognised by the naked eye. While these distributions are usually followed, they are not rigidly invariable, and reversal of the secondary lesions may sometimes be met with. Frew has endeavoured to account for the distribution of the metastases on the basis of the differences between the lymphatic drainage and various connections of the glands on the two sides. On the left side he traces lymphatic paths to join the intercostal lymphatics and thence through the mediastinum to the deep cervical nodes and the base of the skull; communicating branches may also pass to the liver. The right adrenal is in direct contact with the bare area of the liver to which the growth may spread by contiguity, while lymphatic paths along the inferior vena cava may carry the tumour to the pleura and lungs, which are not usually affected by left-sided growths.



Fig. 1832.—ADRENAL NEUROBLASTOMA. THE LIVER FROM THE SAME CASE AS FIG. 1829. PRACTICALLY ALL THE NORMAL TISSUE HAS BEEN DESTROYED AND NUMEROUS HÆMORRHAGIC PATCHES OF GROWTH ARE SEEN

(*Charing Cross Hospital Museum*)



Fig. 1831.—ADRENAL MELANOMA.
(*Charing Cross Hospital Museum.*)

Extension to the bones of the skull may occur subsequently, and an orbital tumour may later appear on the right side.

Another somewhat rare primary tumour of the adrenal is the melanoma (fig. 1831) which arises chiefly in adults, is sometimes bilateral and behaves in general like melanomata in other parts of the body. Following Masson's work on these tumours, in which he definitely connects the skin melanomata with the sensory nerve endings, it seems probable that a neurogenous origin should be given to them.

Metastatic tumours are sometimes found in the adrenals, most commonly in the medulla, and perhaps particularly in association with primary carcinoma of the bronchi. They are then not infrequently bilateral and have been known to give rise to the signs of Addison's disease, though in the majority of cases the primary neoplasm proves fatal before such symptoms can arise.

hæmorrhagic masses are seen and infiltration may be so extensive that hardly any normal liver tissue can be recognised by the naked eye. While these distributions are usually followed, they are not rigidly invariable, and reversal of the secondary lesions may sometimes be met with. Frew has endeavoured to account for the distribution of the metastases on the basis of the differences between the lymphatic drainage and various connections of the glands on the two sides. On the left side he traces lymphatic paths to join the intercostal lymphatics and thence through the mediastinum to the deep cervical nodes and the base of the skull; communicating branches may also pass to the liver. The right adrenal is in direct contact with the bare area of the liver to which the growth may spread by contiguity, while lymphatic paths along the inferior vena cava may carry the tumour to the pleura and lungs, which are not usually affected by left-sided growths.



Fig. 183.—ADRENAL NEUROBLASTOMA. THE LIVER FROM THE SAME CASE AS FIG. 1829. PRACTICALLY ALL THE NORMAL TISSUE HAS BEEN DESTROYED AND NUMEROUS HÆMORRHAGIC PATCHES OF GROWTH ARE SEEN.

(*Charing Cross Hospital Museum.*)



Fig. 1831.—ADRENAL MELANOMA.
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PART XIV
INJECTION THERAPY

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HERNIA

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ST. GEORGE B. DELISLE GRAY

SECTION 2
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SECTION 1

THE INJECTION TREATMENT OF HERNIA

by

ST. GEORGE B. DELISLE GRAY

UNTIL the nineteenth century the lot of the sufferer from hernia of whatever variety was indeed unfortunate. If of the leisured classes he was debarred from strenuous sports or military exercises, and if of the lower orders his livelihood was seriously interfered with, and, in any case, there was not the slightest prospect of cure. Many were the operative and non-operative "cures" advocated and attempted throughout the ages, but without a clear concept of the anatomy of hernia and without our modern knowledge of the causes and prevention of sepsis they were all foredoomed to failure.

The first rational step towards the amelioration of the condition of the herniated was the invention of the steel spring truss in France in the seventeenth century by Nicolas Lequin (1665). At the beginning of the nineteenth century there was no cure for rupture known to the medical profession, and such great surgeons as Pott and Astley Cooper were of the opinion that anyone who operated on a hernia that was not strangulated deserved to be hanged.

Such was the condition of affairs when in 1832 Dr. George Heaton of America hit upon the idea of injecting an astringent into the inguinal canal, and after seven years' patient and, at times, disappointing experiment perfected his technique and soon achieved a large measure of fame. For fifty years he was known far and near, and during that time plied his craft with such a large measure of success that the herniated from all sections of the United States and Canada, of all castes and classes, flocked to him for succour *and to be cured*, so that in a short space of time he reaped a large fortune. He claimed that hernia of every description was curable and convinced many people that such was the case. Not finding the West (i.e. Chicago) a congenial atmosphere for his progress he migrated to Boston, and on his arrival invited the representatives of the medical profession to see him perform his operations. They did not accept this perfectly reasonable

invitation, which was rejected as unheard-of insolence, and he at once became a martyr.

"The public press espoused his cause, and he soon derived the benefit of being gratuitously advertised the world over. He made a triumphal tour through England; was wined and dined in London as one of the greatest benefactors of the age, and re-entered the 'Hub' (Boston), a more popular man than he ever was before. Little wonder that he was lionised, for those who came to him with large old incoercible hernia, for which the most eminent surgeons could offer nothing better than a stiff truss, *left Heaton cured.*" Such is the comment of Manley, one of Heaton's most embittered critics.

However, he kept his method a profound secret, and finally the American Medical Association felt forced to take action.

It was regarded as puerile folly to expect men to close their eyes to the evidence of their own senses, and to allow their prejudices to stand in the way of the acquisition of knowledge. Heaton had a secret. "He might die without revealing it." Hence a committee of the American Medical Association was appointed to wait on Dr. Heaton, request permission to see his operations, and report their observations on their utility and value.

Heaton declined to permit the committee to witness any of his operations or to give them his secret formula; nor can we consider this unreasonable when we remember that his offer to demonstrate his method had been brusquely rejected by the profession some years previously.

The committee, though they were unable from any inspection made either to admit or deny the efficacy of any of Heaton's claims, reported at the next annual meeting "that there is no surgical operation at present known (1852) which can be relied on with confidence to produce in all instances, or even a large proportion of cases, a radical cure of reducible hernia"; commenting on which later Dr. Heaton says: "I affirm to be false *in toto.*"

In 1870 he published his method in a book entitled *The Cure of Rupture*; but the method was so simple that it was laughed to scorn without any investigation whatever, and in a few years Heaton was quite forgotten in spite of his follower, J. H. Warren of Boston, Mass., U.S.A., who attended the annual meeting of the British Medical Association at Cambridge in 1880, discussed with those he met there the injection treatment of hernia and also operated on some cases before a number of surgeons at Guy's Hospital on the introduction of Thomas Bryant. In the same year (1880), he published his *Treatise on Hernia*, which deals with the injection treatment.

The injections of Heaton and Warren were very painful at times, and the modern operative treatment of hernia was so firmly established by the work of Marcy in 1881, MacEwen in 1886, and Bassini and Halsted in 1889, that the very possibility of any alternative method of treatment was very soon forgotten.

About the year 1900, Dr. Ignatz Mayer of Detroit, U.S.A., began the injection treatment of reducible inguinal hernia, using the solution described in this chapter, and with which he claims 98 per cent of cures out of all cases treated.

The first mention of the injection treatment for inguinal hernia in the *Medical Annual* is in 1928, when the reviewer erroneously credits Ignatz Mayer with injecting his fluid into the sac [*sic*], and ends with the remark, "We think most patients would prefer an operation."

The *Medical Annual* for 1931 again refers to the injection treatment, and ends by remarking: "When we remember the scepticism with which the injection treatment of varicose veins was at first received by the profession, it would be unwise to refuse the slightest credence to these observations."

There is a further reference in 1932, but again the reviewer makes the error of suggesting that the injection is into the sac. In the issue for 1933 there is a more detailed reference and the 1934 issue states that the method is increasing in favour, although so far few surgeons have tried it in this country.

It is not denied by the supporters of the injection treatment of hernia that excellent results are obtained by surgery, but it is also common knowledge that operation necessitates a long rest from hard work and is thus economically very expensive.

There is also the risk of the anæsthetic (not negligible) and of post-operative complications, such as pulmonary embolus, pneumonia and bronchitis, and the latter with its accompanying cough may do much to cause the failure of the most carefully carried out operation. In case of failure much time has been consumed, some risk incurred, and the last state of the man is as bad or worse than the first.

In the case of injection treatment failing, the condition of the patient is never worse, but always considerably improved, as herniæ that formerly were difficult to control by truss can now be controlled with ease. The most striking cures by the injection method are those of patients with scrotal herniæ who have been refused operation on account of heart, lung, or other conditions increasing the anæsthetic and operation risks to too great an extent.

INDICATIONS

All reducible indirect inguinal herniæ that can be controlled by a truss are suitable for the injection treatment, provided that the patient is not suffering from tuberculosis, active venereal disease, hæmophilia, or any chronic generalised microbic infection.

Should the patient desire operation, there is no need to dissuade him, but should he be an unsuitable subject for operation, or should he be unable to afford the time or refuse operation absolutely, then he should be urged to undergo the injection treatment which offers an excellent prospect of cure and obviates any lengthy stay in hospital or nursing home followed by a more or less prolonged convalescence. The treatment is ambulatory, free from risk in expert hands, and does not interfere with the patient's professional or social duties. A number of patients who have submitted to treatment at the author's hands are men who felt that their hernia was getting steadily worse and interfering with the efficient discharge of their duties and who, at the same time, did not dare to take the necessary time off for fear of losing their employment.

MECHANICS OF HERNIA

To follow the argument one must understand how a truss keeps back a hernia. In addition to the existence of a sac, preformed or acquired, it is necessary, if the hernia is to "come down," for the external oblique to be separable from the internal oblique and transversalis. If by any mechanical means this separation is prevented, the hernia cannot descend. It is well known that ruptured persons hold themselves when they cough or sneeze to prevent their rupture coming down. A satisfactory truss likewise prevents the descent of the hernia by exerting sufficient pressure on the tissues directly superficial to the neck of the sac to prevent the external oblique from being separated from the subjacent muscles. When ruptured subjects cough, the abdominal musculature is strongly contracted and the conjoined tendon is thus drawn backwards, but the inelastic aponeurosis of the external oblique, although drawn taut, is at a mechanical disadvantage. The neck of the sac may thus be allowed to open and, once contents enter, their semi-fluid character enables them to exert a dilating influence comparable in every way to the dilatation of the birth canal by the unbroken "bag of waters." When the patient is not straining, the conjoined tendon is slack, maintained by intra-abdominal pressure flush against the external oblique, and the hernia does not come down.

This suggests that if we could prevent the external oblique from separating from the subjacent muscular layers, the hernia would never "come down," in spite of the existence of a sac. This is what is attained by the injection treatment first devised by Dr. George Heaton of Boston, Mass., just over one hundred years ago, and perfected by Dr. Ignatz Mayer of Detroit, whose technique is here advocated.

By means of a suitable sclerosing fluid, a mass of tissue—microscopically a foreign-body granuloma—is formed in the inguinal canal between the layers of the lower abdominal muscles and surrounding the sac and spermatic cord. The layers of muscle are firmly united together by the subsequent dense scar tissue by which it is replaced so that they cannot be separated, while the contraction of the scar tissue also constricts the neck of the sac and the hernia is cured.

There is nothing new to the surgeon in this idea of scar tissue causing very considerable alteration in the mechanics of the human body. It is well known to every gynecologist that if a woman has pelvic cellulitis following a confinement, the uterus is, first of all, pushed over to the opposite side by the exudation. As resolution takes place, the uterus gradually returns to its mid-line position, and, finally, is dragged to one side and upwards by the contracting scar tissue. The uterus remains firmly fixed in this new position, thus giving permanent evidence of former inflammation and exudation.

Although many thousands of cases of hernia have been treated by the injection method by various surgeons in other countries, there has been reported no case of injury to the testis or cord. Sections cut from experimental animals show that the cord passes undamaged through the areas of artificial induration and remains uninjured by the subsequent contraction of scar tissue. It is essential that a well-fitting truss should be worn from the commencement of treatment and *never removed, day or night*, until several weeks after the final injection. The surgeon must see that the pad accurately covers the internal ring and that, even when the patient is lying down, it is still exerting adequate pressure.

It must be of the steel spring pattern; the elastic truss is, in the author's experience, useless.

For the treatment to be successful, the hernia must be (a) entirely reducible, and (b) easily retained by a truss. The size of the hernia does not matter; scrotal herniæ are cured as well as the smaller varieties.

TECHNIQUE OF INJECTION

The patient is examined to make sure that he has a hernia which is completely reducible, and his own medical adviser is also asked to verify that he has a hernia (fig. 1832).

This latter precaution is highly necessary, for when the patient is cured there is nothing to show for it except a hard mass in the groin, and those who have not seen the hernia "down" are incredulous as to cure. It is highly important to examine both sides before commencing treatment, to avoid missing a second hernia unnoticed by



Fig. 1832.—PATIENT WITH RIGHT INGUINAL HERNIA DESCENDING INTO THE SCROTUM. THE PUBIC HAIR ON THE RIGHT SIDE HAS BEEN SHAVEN FOR GREATER COMFORT AND CLEANLINESS IN WEARING THE TRUSS.

the patient. In a certain number of cases, especially left inguinal hernia, the cure of one side is followed by the appearance of a hernia on the other side. This second hernia may appear during the treatment of the original hernia, and, therefore, where the opposite inguinal region appears weak and especially when the external ring is large, it is wiser to inject both inguinal canals simultaneously, in order to forestall the annoyance of a fresh hernia developing.

A well-fitting truss must next be obtained—a steel spring truss with a perineal band or else of the rat-tail type (figs. 1833 and 1834). Care must be taken to see that the hernia is retained under all conditions. The loop of the perineal band should be stitched to the covering of the spring

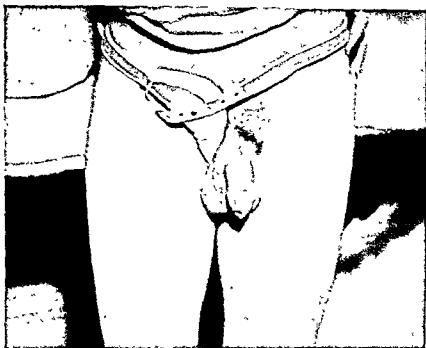


Fig. 1833.—THE SAME PATIENT FITTED WITH A SUITABLE STEEL SPRING TRUSS OF RAT-TAIL PATTERN.

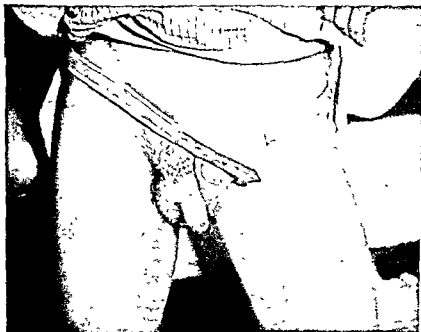


Fig. 1834.—STEEL SPRING TRUSS, RAT TAIL TYPE, FOR LEFT INGUINAL HERNIA.

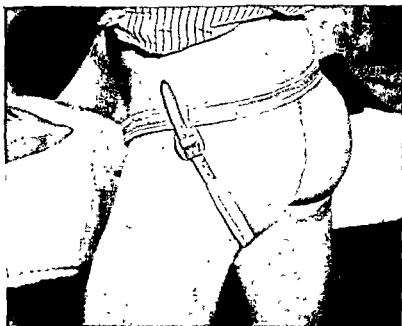


Fig. 1835.—TRUSS SEEN FROM THE BACK WITH THE BUCKLE IN THE CORRECT PLACE. IF THE BUCKLE IS NOT STITCHED IN PLACE IT SLIPS ABOUT AND THE STRAP FINALLY COMES TO REST IN THE INTER-NATAL CLEFT AND IS SOILED BY FACES, IN ADDITION TO BECOMING SLACK. NOTE THE TRANSVERSE MARK ON THE STRAP SHOWING THAT IT SHOULD BE TIGHTENED UP ONE MORE HOLE. THIS MARK ALWAYS APPEARS IN ABOUT A WEEK OF WEARING THE TRUSS AND SERVES TO INDICATE THE CORRECT HOLE.

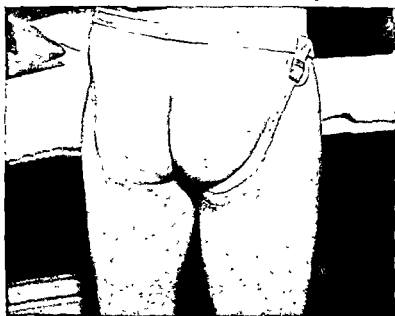


Fig. 1836.—THE CORRECT WAY TO WEAR A TRUSS. THE BUCKLE BEING STITCHED IN THE POSITION SHOWN, THE PERINEAL BAND IS KEPT OUT OF THE WAY OF FACES AND REMAINS CLEAR.

in the most convenient position (figs. 1835 and 1836), otherwise the band slips about, gets into the inter-natal cleft and is soiled with *fæces*, etc. (fig. 1837).

The patient is shaved on the affected side. Lloyd's "Euxesis" is recommended for softening the hair before shaving, but any similar cream will do. A dry shave is a barbarity.

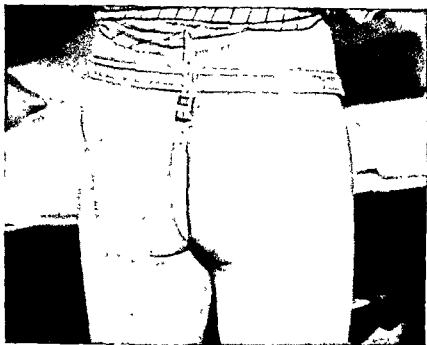


Fig. 1837.—THE WRONG WAY TO WEAR A TRUSS. THE PERINEAL BAND IS CERTAIN TO BE SOILED WHEN THE BOWELS ARE OPENED.

The injection is made with the patient in a modified Trendelenburg position (fig. 1838). A pelvic rest placed under the sacrum raises that part of the body some six inches above the level of the couch, the head and feet resting on the couch at a lower level. The patient's muscles must be quite relaxed. The site of the injection is now washed with industrial alcohol.

If the external ring is large enough, the skin of the scrotum is invaginated through the external ring by the third finger of the *right* hand if the operator stands on the *right* side of the patient, and with the same finger of the *left* hand if he stands on the *left* side of the patient. The needle, No. 23 B.W.G. (British Wire Gauge), $1\frac{1}{2}$ inches



Fig 1838.—PATIENT LYING ON COUCH ON PELVIC REST. THE TRUSS IS NOW REMOVED BY THE SURGEON WITHOUT DISTURBING THE PATIENT IN THE SLIGHTEST.

long, such as is made by Messrs. Allen & Hanbury, *without* a side eye near the point, mounted on the charged syringe, is inserted vertically over the site of the internal ring until the point is felt by the invaginating finger to have pierced the external oblique aponeurosis and to be lying in the inguinal canal (fig. 1839). The piston is withdrawn to ensure that no vessel has been entered. The contents of the syringe



Fig 1833.—INJECTION BEING MADE INTO THE LEFT INGUINAL CANAL. NOTE THAT IN THIS CASE THE RIGHT MIDDLE FINGER INVAGINATES THE SCROTAL SKIN THROUGH THE EXTERNAL RING INTO THE INGUINAL CANAL. THE NEEDLE IS INSERTED VERTICALLY THROUGH SKIN AND EXTERNAL OBLIQUE, AND THE INVAGINATING FINGER FEELS THE POINT DEEP TO THE EXTERNAL OBLIQUE. AFTER A FEW INJECTIONS THE INCREASING MASS OF INFLAMMATORY EXUDATION MAKES THIS MANŒUVRE IMPOSSIBLE.

are now slowly injected, withdrawing the piston after every few drops to make certain that the point of the needle is still outside any vessel.

It is often impossible with a small hernia to lift the external oblique as suggested above; in these cases the needle may be inserted through the external ring into the inguinal canal either above or below the cord, which is identified and held out of the way, or the neighbourhood of the internal ring may be reached by inserting the needle vertically to the skin at a point just above Poupart's ligament and immediately external to the termination of the external iliac artery, which is identified by palpation.

PREPARATION OF SCLEROSING FLUID

The following is Mayer's formula :

Zinc sulphate	1 dr.
Phenol crystals	6 dr.
Glycerin	4 fl. dr.
Aq. cinnamoni	1 fl. oz.
Fluid ext. pinus canadensis (dark)	5 fl. dr.
Sterilised chemically pure redistilled water	2 fl. oz.

Dissolve the zinc sulphate in the cinnamon water. Liquefy the phenol crystals by heating. Add the glycerine. Shake thoroughly until mixed and cooled, then add the distilled water and finally the fluid extract of pinus canadensis. Shake thoroughly. Allow the fluid to stand for about a week, agitating the mixture several times a day. Subsequently it should be filtered. Before injecting, boil the solution in a glass tube or place in the sterilizer in a porcelain container.

When cold the solution is muddy in appearance, but on heating it becomes clear and transparent and looks like a rich port wine, hence the necessity for the clear glass, for if amber containers are used it is difficult to see when the solution has become clear.

On drawing up the solution into the syringe it becomes cooler and throws down a very fine precipitate which passes without difficulty through the needle. In this precipitate is, the author believes, the whole virtue of the solution.

The dose is 0.5 cc. for the first injection and 0.5 to 1 cc. for subsequent injections.

AFTER-TREATMENT

When the injection is completed, the needle is rapidly withdrawn, the site dried with cotton wool, the groin dusted with talcum powder, and the truss re-applied by the surgeon. It is very important to impress on the patient that he must not endeavour to help the surgeon in any way, but must lie quite flaccid, "like a log," and not cough or strain until the truss is on once more. When the truss is fitted, the patient rises and gets down off the couch without much assistance. In a few hours' time there may be a bruised feeling in the groin. If this is severe he should lie down, apply a hot-water bottle on top of the truss (*which must not be removed*), and take ten grains of aspirin.

At four to seven days' interval (according to the reaction), further injections are given in the same manner as the first. The patient gets on to the couch and lies on the pelvic rest with his truss on, and this is

removed by the surgeon, who must warn him every time not to try and help in any way, but lie quite flaccid. Patients find it difficult at first to get this important point into their heads.

After a few injections a hard mass is noticed deep in the inguinal region, and this gradually increases in extent as the injections proceed. When the entire inguinal region is so filled up, it is impossible to identify the external ring and the needle feels as if it is being inserted into rubber. The injections are now left off for a fortnight, the patient still wearing the truss day and night. At the end of this time the truss is removed by the surgeon with the patient lying on the pelvic rest, as if for injection, and he is asked to cough. No impulse should be visible or palpable. The truss is then re-applied and still worn day and night, and in another fortnight's time is removed with the patient standing, and he is again asked to cough. No impulse should be visible or palpable, and the patient may now leave off the truss at night and when having a bath, but he should be examined in a week's time, and it should continue to be worn during the day for a further period of four weeks. He is then re-examined and the truss left off for good, but he is examined in a week's time and again three or four weeks later. If he has to make any strenuous exertion he is advised, as a matter of precaution, to wear his truss during the periods of stress for several months to come.

The total number of injections is about twenty.

It is important to remember that the fluid is not injected into the sac, but into the inguinal canal in the neighbourhood of the internal ring.

Some of the earlier experimenters, e.g. Pancoast and others, at the beginning of the nineteenth century, did actually expose the sac and inject into it, but results do not appear to have been encouraging, for we hear nothing further of this method.

Occasionally when the needle is inserted through the external ring some coagulable fluid is aspirated into the syringe. With the needle *in situ* and fresh syringe substituted, it can be demonstrated that the fluid is clear and colourless, highly albuminous, and with a few white corpuscles and still fewer red. This is probably peritoneal fluid from the hernial sac which has been entered by accident. The needle should be withdrawn and inserted afresh in a slightly different direction. In experimental animals the entry of the sclerosing fluid into the general peritoneal cavity has been followed by a plastic peritonitis with death within a few days from obstruction due to adhesions and bands.

If a blood-vessel has been entered, blood flows into the syringe on withdrawing the plunger, and its recognition presents no difficulty.

Should the patient, on the injection of the first few minims of the fluid, complain of cramp-like feelings in the hypogastrium or abdomen, it is probably a sign that the point of the needle has entered the general peritoneal cavity, and the needle should be withdrawn a short distance before continuing the injection. No ill results ensue, but there may be considerable discomfort for some hours following.

Patients frequently complain of curious transient subjective sensations, such as burning in the scrotum or penis, or on the inner side of the thigh, or a sensation of warmth round the anus. Occasionally, a few seconds after an injection in the neighbourhood of the internal ring, there may be a feeling of cramp in the distribution of the anterior crural nerve, followed by some paresis, which disappears in the course of a few days, leaving the patient none the worse.

Very occasionally, injection in the neighbourhood of the internal ring is followed by tingling down the leg and in the foot and toes, suggesting that the fluid has reached the peri-arterial sympathetic plexus surrounding the external iliac artery, or even that a small amount has entered the vessel. No permanent injury follows.

No case of new growth has yet been reported following on the artificial foreign-body granuloma.

DISCUSSION

The following advantages may be claimed for the injection method over operation :

- (1) The risk of an anæsthetic and operation is avoided.
- (2) The treatment being ambulatory, the need of going into a hospital or nursing home is removed, and there is no loss of time from employment or enjoyment, thus effecting a considerable economic saving.
- (3) The pain and discomfort of the injection treatment is very much less than that of operation. Patients who have experienced both methods are enthusiastic in favour of the former.
- (4) According to those in other countries who have had a large experience running into thousands of cases, end-results compare favourably with those of operation.

The following types of cases are unsuitable for treatment by the injection method :

- (1) Those in which the hernia is not completely reducible, or where it is complicated by imperfect descent of the testis or some other condition rendering the satisfactory fitting of a truss impossible.

(2) Those in whom there is active venereal disease or any kind, or a definite history of tuberculosis. Mayer also considers a history of specific disease as a contra-indication.

(3) Those cases where the intelligent co-operation of the patient cannot be assured. For this reason it is not recommended for children, as their mothers cannot as a rule be relied on to see that the truss is properly worn day and night. In children, too, the loss of time entailed by an operation is not a serious factor.

(4) Cases of hæmophilia.

The following equipment is necessary :

A couch of more than average length, say 6 ft. 9 ins. The short couches sold by many of the instrument makers are of very inconvenient size. During the injection the patient is perched in a position of opisthotonus with his head and his heels at either end of the couch and his pelvis supported on a pelvic rest (a truncated wedge of the following dimensions: width of base 15 ins., height 6 ins., width of upper surface 7 ins.) (fig. 1840). With too short a couch, the head or heels of a tall patient are just on the edge and he is unable to relax completely through fear of slipping.

The rest is just a little shorter than the width of the couch. The upper surface is covered with two layers of sorbo cushion held in place by a layer of waterproof sheeting which is securely nailed to the wooden portion of the pelvic rest. This is very cold to the skin, and it is advisable to have some small blankets, of such a size as are used in perambulators, for covering the rest, thus saving the patient from much discomfort. The blankets can be washed as required and need



Fig 1840.—Couch with Pelvic Rest.
N.B. THE LATTER IS COVERED WHEN
IN USE BY A SMALL BLANKET.

not be fastened in any way.

The syringes should be of the eccentric nozzle type and in two sizes, of one and two cubic centimetres capacity respectively, graduated in tenths of a cubic centimetre and also in minims. The needles that are most satisfactory are of size 23 B.W.G., $1\frac{1}{2}$ inches in length, and with a terminal aperture, bevelled so that the "eye" of the needle faces the flat part of the shoulder of the needle. There must not be any lateral aperture or apertures near the point as is so frequently seen in needles of this description. *This is very important.*

The syringes and needles are kept immersed in industrial alcohol. This can now be obtained on a written order by a qualified medical practitioner, in quantities not exceeding half a gallon at a time, from any chemist with a licence to dispense it. The order must specify the use to which the alcohol is to be put, and must bear the prescriber's name, address and qualifications, and the date. Industrial alcohol is highly preferable to methylated or surgical spirits, and can be used "neat" as a sterilising fluid for instruments or skin. The privilege of obtaining what is practically pure alcohol at a moderate price is so valuable to the profession that great care must be exercised to avoid any infringement of the rather stringent regulations for its supply.

For those who perform this operation frequently it is advised that the needles and syringes be kept in a shallow, flat, rectangular dish large enough to contain two or three syringes each of either size and half a dozen or more needles. One side of the dish should have an indelible mark and the syringe and needle nearest to this side is the one next to be used. After use the syringe and needle are washed out several times with tap water (from the warm tap for preference) and then run through spirit and replaced in the dish furthest from the marked side. In this way each syringe and needle is used in turn and receives a sufficiently long immersion in the alcohol to effect thorough sterilisation.

It is important that all instruments immersed in sterilising fluids, of whatever nature, should be in contact on every surface with the fluid. This means that there shall be sufficient depth of alcohol, and that hollow instruments (needles, etc.), shall be completely filled with alcohol and all bubbles of air carefully excluded. Needles, therefore, must have alcohol passed through them and be detached from the syringe before the syringe is empty. *This ensures that the lumen of the needle is full of alcohol.*

Syringes and needles immersed in industrial alcohol should have the alcohol blown as completely as possible out of them before use, but need not be rinsed in water. This is an additional advantage, saving time and trouble. *If any other sterilising fluid is used it is absolutely necessary to wash the instruments thoroughly in sterile water before use.*

It is convenient to have a jar filled with alcohol containing pledgets of cotton wool for sterilising the skin before making the injections.

It is far easier to gauge the size of the external ring with the patient

lying on the pelvic rest in perfect relaxation, as described above. When the patient is examined standing, the abdominal muscles are in a condition of tonic contraction and the pillars of the external ring are drawn taut. This makes the insertion of the examining finger a painful and often impossible process.

Always make the injections as far from the mid-line of the body as possible, to start with. One of the causes of failure is making the injections too near the external ring.

It is helpful to mark the extent of the hernia by a series of minute, intradermal injections of indian ink. This leaves a permanent tattoo



Fig.—1841. THIS PATIENT HAD A DOUBLE HYDROCELE WHICH COMPLETELY PREVENTED THE FITTING OF A STEEL SPRING TRUSS TO CONTROL HIS RIGHT SCROTAL HERNIA. HE WAS FITTED WITH THE "BAG TRUSS" HERE ILLUSTRATED, SUPPORTED BY A STRAP OVER HIS SHOULDER.



Fig. 1842.—THE SAME PATIENT AS IN FIG. 1841 AFTER CURE OF HIS HYDROCELES. HIS RIGHT INGUINAL HERNIA WAS THE SIZE OF A FETAL HEAD AND THE "BAG TRUSS" WAS NOW FAR TOO LARGE AND QUITE USELESS.

record of the size of the hernia, and is very useful for recalling to mind the original condition of the patient. One dot should be made at the outermost limit of the hernial bulge, i.e. at the external boundary of the internal ring. This is important, as if there is a recurrence it will begin just internal to this point.

The following brilliant success in a very unpromising case should convince the most sceptical of the value of the injection treatment :

In the autumn of 1931 the author saw an elderly man of seventy-one years of age with a large double hydrocele of fourteen years' standing and a right inguinal hernia of ten years' history. His hydroceles had been tapped at frequent intervals, but his hernia was impossible to control on their account (fig. 1841), and as he had had a stroke some few years previously (from which he had, however, made a practically complete recovery), and was also subject to attacks of bronchitis in cold weather, operation was considered quite out of the question and he was

passed on to me with the suggestion that I might like to inject his hydroceles.

Against my better judgment, and in spite of the long history and thick sac walls, it was decided to make the attempt, and each hydrocele was evacuated seriatim and injected with 10 cc. of quinine-urethane solution as used for varicose veins.

The hydroceles were quickly cured, and then it was possible to fit a steel spring rat-tail truss which retained the hernia perfectly.

The hernia was the size of a foetal head (fig. 1842), and the external ring was so large that the middle finger could be inserted through it up to the metacarpo-phalangeal joint. If this case could be cured, the value of the injection treatment was, indeed, established beyond all doubt.

On January 4th, 1932, injections for the hernia were begun, and between that date and August 8th, 1932, twenty-four injections of Ignatz Mayer's solution were given into the right inguinal canal. On September 5th, 1932, the truss was left off at night, and on October 3rd of the same year it was finally discarded. There is now, two years after discarding the truss, not the slightest sign of either the hydroceles or the hernia (fig. 1843).

It must be emphasised that this is essentially a specialist treatment. The long technique cannot be learned without months of patient and often disappointing practice, and, at first, the operator is bound to have a certain percentage of failures, all of which on subsequent searching self-examination can be attributed to faulty technique or selection. This treatment is now on trial at the Mayo Clinic; and in the Surgical unit of the University of Minnesota, where Dr. Arthur F. Bratrud, Professor of Surgery, has been using Mayer's solution for the last three years, very encouraging results are reported. The use of the injection method is on the increase in the United States, and wherever it has been given a fair trial results have impressed those that have witnessed them.

It is an interesting fact that the opponents of this treatment are all, without exception, men who have never seen the treatment carried out at all, or only in a half-hearted manner, or who have only seen one



Fig. 1843.—SAME PATIENT AS IN FIG. 1842 ONE YEAR AFTER COMPLETION OF TREATMENT. IN HIS PRESENT CONDITION THERE IS NOT THE SLIGHTEST TRACE OF EITHER HERNIA OR HYDROCELE.

case and that a failure. On this they base their judgment. To them I would recommend the words of William Penn uttered 250 years ago : " Neither despise, nor oppose, what thou dost not understand."

The following references may be looked up by those interested in the injection treatment of hernia :

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SECTION 2

THE INJECTION TREATMENT OF HÆMORRHOIDS

by

R. SIMPSON HARVEY

INTRODUCTION

HÆMORRHOIDS—or piles, as they are commonly called—usually occur in middle life, though they are not uncommon in the second and third decades; they affect both sexes equally. In many cases they appear to be hereditary.

They are due to varicosity of the hæmorrhoidal plexus of veins, and are caused by :

(1) Constipation. Normally the rectum should be free from fæcal matter except during defæcation. In chronic constipation, fæces are more or less constantly found in the rectum and, becoming unduly hard from the absorption of water, they exert pressure on the superior hæmorrhoidal veins. Contraction of the rectal wall is increased and the veins are constricted as they pass through the muscular layers. Forced efforts at stool increase the pressure in the portal system, and dilatation and varicosity of the veins result.

(2) Spasm of the rectal musculature caused by worms, fissures, or shells of hard scybalous material retained beneath the valves of Houston, as is sometimes found when the mucosa is unduly lax.

(3) Raised portal pressure from disease of the liver, and raised intra-abdominal pressure from tumour or forced expiratory efforts.

(4) Loss of muscular tone and relaxation of the sphincters and levatores ani, such as occurs in multigravidæ who have unrepaired torn perinei.

(5) Pressure on the rectum by pelvic tumours or by retroversion of the uterus.

(6) Sedentary occupations.

The varicosity may take place in the veins of the columns of Morgagni—internal piles—or in the lower veins of the anal canal—external piles. Intermediate forms are termed intero-external piles.

Internal piles may prolapse outside the anus, temporarily or permanently, and become thrombosed or even gangrenous; external piles frequently become thrombosed.

As in varicose veins of the leg, relief or cure may be effected either by aseptic thrombosis of the varicose veins themselves, or by prolonged support and constriction of the whole venous system of the part. In any case the causes must be discovered and treated.

Aseptic thrombosis of the varicose veins of the pile mass may be effected by the injection of a few minims of sclerosing fluid, such as 20 per cent phenol in glycerine, into the pile itself. This method was in vogue in America more than fifty years ago and was first introduced into England by Swinford Edwards in 1888. It is still practised by many leading proctologists and gives excellent results. Each pile must be injected about three times, at weekly or fortnightly intervals, before a cure can be effected.

Complications, such as severe bleeding, pain, or necrosis of the mucous membrane, were common, however, until an improved technique was introduced in America by the late Albright of Philadelphia and Blanchard of Youngstown. This consists of injecting into the submucous tissue of the rectum *above* the piles a 5 per cent solution of phenol in vegetable oil. This would appear to have two separate effects; it seeps down into the pile to produce a thrombosis of the varicosity, and it further produces fibrosis of the submucous tissue. The mucous membrane of the rectum becomes more firmly attached to the muscular coats and firm support is given to the walls of the superior hæmorrhoidal veins.

The first to introduce this method into England was Morley in 1927, and he substituted almond oil for the wesson oil which was in use in America. This method, which is used at the Injection Clinic of the Royal Waterloo Hospital, is the one we would advocate and is here described.

EXAMINATION OF THE PATIENT

(1) *General Examination.* A general routine examination of the patient should be made, to discover if possible the cause of the complaint. It cannot be too strongly emphasised that piles are a manifestation of sluggish circulation of blood in the hæmorrhoidal plexus, and,

if no local causes can be found, attention must be directed to the portal circulation, and to the liver in particular.

(2) *Local Examination.* The best position for both men and women is the left lateral semi-prone. The buttocks should be well up to the left side of the couch and the head and shoulders to the right. A small pillow should be placed under the left hip. The knees should be drawn up—the right higher than the left—and should rest on the couch. The surgeon should wear rubber gloves for the examination. The external parts should then be examined in a good light to ascertain the presence of sores, tags, external piles, or fissure.

The gloves may now be discarded and a rubber sheath be placed on the index finger of the right hand. The examining finger must be well lubricated and slowly introduced into the anus. Spasm of the sphincters or a complaint of acute pain should suggest the possibility of the presence of fissure.

A very complete and careful digital examination of the rectum and pelvic organs should now be made. It must be emphasised that no internal hemorrhoids will be felt unless they are inflamed, thrombosed, or fibrosed.

If masses of faeces are felt they may often be pushed into the upper part of the rectum; if they are too soft and bulky it may be impossible or impracticable to proceed with the proctoscopic examination and injection until the bowel has been cleared.

TECHNIQUE OF INJECTION

(1) *Solution.* In most cases a 5 per cent solution of phenol in almond oil is used, but in some cases where the mucous membrane of the rectum is unduly lax the strength of the solution may advisably be increased to 10 per cent. It is convenient to keep a stock of the latter and to mix it with equal parts of pure sterilised almond oil, as required, to produce the 5 per cent solution.

The 10 per cent solution is made as follows:

Ten grammes of pure phenol crystals are weighed out into a crucible and melted in a water-bath; 95 cc. of pure almond oil is placed in a stoppered bottle and sterilised at 100° C. by boiling in a water-bath for half an hour. When it has cooled down, the phenol is added and thoroughly mixed by shaking. There should be no deposit of any kind. The resultant fluid measures 100 cc. It is strongly antiseptic and will keep, but should be well shaken every time before use or before being diluted to make the 5 per cent solution.

(2) *Syringe*. The syringe is a 10 cc. Record pattern Gabriel's pile syringe (modified), with a bayonet mount for the needle. The needle is 12 gauge, $\frac{1}{2}$ inch long, and in a stem $4\frac{1}{2}$ inches long; close to the bayonet

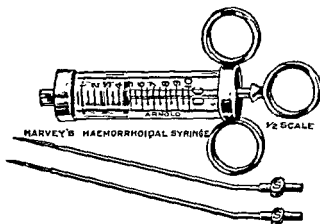


Fig. 1844.—SYRINGE AND NEEDLES AS RECOMMENDED FOR THE INJECTION TREATMENT OF HAEMORRHOIDS

mount the stem is bent at an angle, and so arranged that, when mounted, it points away from the plane of the finger mounts of the syringe (fig. 1844). Thus when the needle is introduced into the proctoscope the surgeon's view is not obstructed by the end of the syringe or by the hand, and a clear view of the operation area is obtained.

(3) *Proctoscope*. Many varieties of proctoscope have been devised, but the one I have found most useful and most acceptable to the

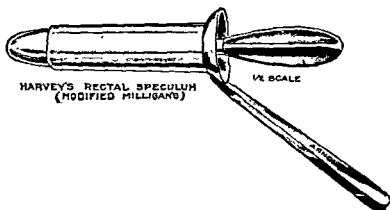


Fig. 1845.—PROCTOSCOPE.

patient—a very important point—is a modification of that devised by Milligan. It is longer and narrower than most, consists of a simple tube with a very slight taper, and is fitted with a conical obturator (fig. 1845). It is easy to introduce and easy to clean. I have modified the

pattern slightly by having the handle bent backwards at an angle of 45° to give more room for the buttocks when it is fully introduced.

(4) *Illumination.* An electric head-light is the most convenient source of illumination.

(5) *Lubrication.* Vaseline, though an excellent lubricant, is messy and difficult to clean off instruments and rubber finger-sheaths, and soon rots the rubber. A water-soluble catheter lubricant, such as is supplied in tubes, is recommended.

A pair of long forceps is needed to carry wool swabs to clean the inside of the rectum when necessary.

(6) *Introduction of the Proctoscope.* The rubber sheath may now be discarded, and the warmed and well-lubricated proctoscope gently introduced.

It is better to tell the patient to relax and avoid any straining or "bearing down," as the latter may cause the passage of feces into the lower portion of the rectum.

The proctoscope should be directed towards the umbilicus for the first inch or so, as this is the direction of the axis of the anal canal; a to-and-fro screwing movement assists its passage. It should then be directed upwards and slightly backwards to its full extent, and the obturator removed. If the patient is in the position described above (more particularly in the knee-elbow position), air will enter the rectum and partially distend it. A good view of the rectum is obtained. Blood, mucus and faecal matter should be gently swabbed away or mopped up.

The proctoscope is then withdrawn to allow the lower portion of the rectum to be seen. If piles are present, they will prolapse into the lumen as the proctoscope is withdrawn. In a well-marked case there will usually be three large piles—two on the right wall and one on the left, corresponding to the three main branches of the superior hæmorrhoidal vessels—and smaller intermediate piles. Their number, position and size should be carefully noted, and later recorded on a chart. It is convenient to regard the rectum as being divided into four quadrants by imaginary antero-posterior and transverse lines, and to inject one quadrant at each sitting.

(7) *The Injection.* Being satisfied that internal piles are present and that the case is suitable for the treatment, the injection may now be started.

The obturator should be carefully re-introduced and the proctoscope passed into the rectum almost to its full extent, and the obturator then withdrawn. The syringe, which should have been previously sterilised, warmed, and filled with the *warmed* solution of 5 per cent phenol in almond oil, is taken in the right hand.

The injection is usually made about one-third of an inch above the upper end of the proctoscope in that quadrant of the rectum in which the pile mass about to be treated is situated. The needle *must* be sharp (see page 3287).

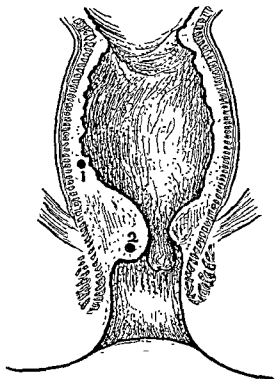


Fig. 1846.—THE INJECTION TREATMENT OF HÆMORRHOIDS. THE ANAL CANAL AND RECTUM ARE SEEN IN SECTION. 1—THE SITE FOR THE HIGH INJECTION; 2—THE SITE FOR THE LOW INJECTION INTO THE SUBSTANCE OF THE PILE ITSELF.

Some experience is necessary to determine at what height the injection should be made; it varies from 1-3 inches or more above the ano-rectal line, but in general the greater the pile and the laxer the rectal *mucous membrane*, the higher the injection is made (fig. 1846).

The mucous membrane must be pierced steadily—there must be no stabbing, or a fold will be produced and transfixed—until the point of the needle is judged to be in the submucous tissue. This can be proved if the shaft of the needle is moved radially towards the centre of the proctoscope, when the point of the needle will come with it carrying

the loose mucous membrane. If the point has impinged too deeply it will be fixed in the muscular wall and will not move, necessitating its being withdrawn a little.

Slight suction on the plunger should be made to see whether blood enters the syringe: if this occurs, the needle is in a blood-vessel and must be withdrawn and the injection made elsewhere.

Being satisfied that the needle is in the submucous tissue and not in a blood-vessel, the injection may be proceeded with steadily (fig. 1847).

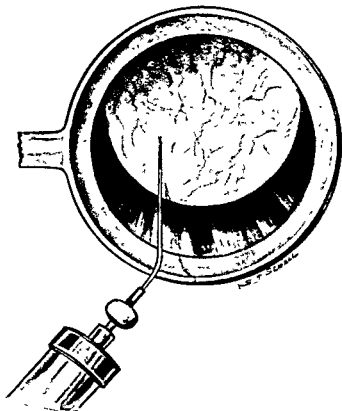


Fig. 1847.—INJECTION TREATMENT OF HÆMORRHOIDS. THE INJECTION IS BEING PERFORMED. THE FIGURE SHOWS THE PROCTOSCOPE IN POSITION. A HIGH INJECTION OF PHENOL IN OIL IS BEING GIVEN AS DESCRIBED IN THE TEXT.

The amount injected varies with each case and depends largely on the looseness of the mucous membrane on the deeper tissues. Enough fluid should be injected to produce a swelling of the mucous membrane, which usually turns pale and over which small blood-vessels can be seen coursing—the so-called “striation sign.” When this appears, enough solution has been injected. The amount varies from 3 cc. (in a thin, poorly nourished individual) to 10 cc. At one sitting I rarely give less than 6 cc. and very often inject the whole content of the 10 cc. syringe.

On withdrawing the needle there should be no bleeding, or at most only a tiny trickle of blood, from the puncture spot.

If bleeding seems to be excessive, a pad of wool should be introduced through the proctoscope and left in the rectum opposite the bleeding point, to control it. The wool will be evacuated at the next movement of the bowels.

It is well to re-introduce the obturator before withdrawing the proctoscope so that the edge of the latter shall not injure the skin of the anus as the sphincters contract.

A record should be made of the site of the injection and the amount of solution used, and the patient be told to report in a week's time. A tablespoonful of liquid paraffin should be taken every night until the treatment is completed.

After-Treatment. Every endeavour must be made to eradicate the causes which may have accounted for the hæmorrhoids. Constipation in particular must be avoided and the bowels be kept free, without being too loose, by taking paraffin either in the liquid form or combined with agar-agar in an emulsion. A clock-like regularity of evacuation should be enjoined and the patient warned never to break it even once.

EFFECTS OF THE INJECTION

The visible effects have already been described. Pain at the time of injection is very rare, but a sense of fulness is usually experienced which may persist for some hours. Subsequent pain is very uncommon, and rarely enough to incapacitate. It may be relieved by a belladonna suppository, $\frac{1}{4}$ gr. When a bleeding pile has been injected the hæmorrhage ceases immediately. This may lead the patient to imagine that he has been cured by one injection only, so that it is well to warn him of the fact and to impress upon him the necessity of completing the treatment.

At the next visit the examining finger will feel an induration of the rectal wall extending from just above the site of the injection down to and sometimes into the anal canal. The mucous membrane feels "leathery" and can no longer be moved on the deeper layers. The pile itself feels hard and thrombosed. When the proctoscope is introduced, the mucous membrane in that quadrant which has been injected will not prolapse into its lumen. The injected pile has shrunk and no longer looks congested.

When the four quadrants have been fully injected it is well to defer further treatment for a month or six weeks. It will then be found that though the induration and swelling of the rectal mucous membrane have to some extent subsided, yet the former laxness and undue mobility have entirely disappeared. Even anal tags and external

piles, if formerly present, will have decreased in size. If any small internal piles remain they may be dealt with by an injection of 2 or 3 cc. into the submucosa just above their upper ends (fig. 1848). These small piles are more readily cured by injecting them with 5 minims of the stronger solution, i.e. 20 per cent phenol in glycerine. It is rarely necessary to repeat the large injections higher up—indeed this may be impossible owing to the fixation of the mucous membrane.

The immediate results of injection treatment are excellent in that the local symptoms are cured. Bleeding and pain are relieved almost from the time of the first injection. Congestion and swelling of the pile-bearing area disappear, and the complexion of the rectal wall changes



Fig. 1848.—INJECTION TREATMENT OF HÆMORRHOIDS.
VIEW OF THE PARTS AS SEEN THROUGH THE PROCTOSCOPE.
THE DOT INDICATES THE SITE OF THE HIGH INJECTION,
I.E. JUST ABOVE THE PILE.

from a dusky red to a healthy pink. With the relief of the congestion, the muscles of the rectum and pelvic floor regain their tone, the sphincters become noticeably stronger, and external piles and anal tags tend to shrivel.

The general health of the patient improves; his complexion becomes clearer and his sclerotics brighter. Mental depression is relieved. Only those who have suffered from hæmorrhoids can realise the insidious poisoning to the bodily and mental functions which this complaint creates.

COMPLICATIONS

(1) Injection may inadvertently be made into a vein. This should never occur if due precautions are taken. Such a mishap will cause severe

localised thrombosis with very painful induration of the rectal wall high up above the injection. Pain may be very severe for a week or more. The patient should be put to bed and treated with hot rectal saline injections and hot sitz baths. Morphia may be necessary to control the pain, but the bowels should be kept regulated with liquid paraffin with, if necessary, confection of senna. The condition subsides in the course of a week or so and apparently no permanent damage results.

(2) The injection may be made too superficially into the layers of the mucous membrane itself, causing a white glistening, circumscribed swelling to appear at the point of injection. The increased force necessary to depress the plunger of the syringe should be a warning sign. If an injection is made under these circumstances, sloughing of the wall occurs with the formation of a painful shallow ulcer. If it is realised that such an accident has occurred, an attempt should be made to aspirate the oily fluid back again. If this is impossible, the swelling should be incised with a bistoury to allow the contents to escape.

(3) The injection may be made too deep and the fluid be forced into the muscle wall, or the needle may even pierce the wall and enter the prostate or vesicula seminalis in the male, the uterus in the female, or the peritoneal cavity in either. This is obviously due to bad technique and results in painful indurations in the injected area, and possibly the subsequent formation of an abscess which may require surgical treatment.

(4) The injection may show no result, even after a week or more. In such a case, it should be repeated, using a solution of 10 per cent phenol in almond oil instead of the usual 5 per cent.

CONTRA-INDICATIONS

Maingot considers the injection treatment to be contra-indicated in the following conditions :

(1) *General conditions* such as advanced cardiac, renal, or hepatic diseases.

(2) *Local conditions.*

(a) Chronic anal fissure.

(b) Fistula in ano.

(c) Cases with extreme prolapse.

- (d) Where the external sphincter muscle is lax and inefficient.
- (e) Neoplastic diseases of the rectum.
- (f) Where the injection treatment has obviously failed after a fair trial.
- (g) Where the introduction of a proctoscope is associated with excessive pain or discomfort.
- (h) Where the piles are inflamed, thrombosed, or fibrotic.

In several of the above conditions, however, especially in the case of advanced cardiac or hepatic disease, it may sometimes be justifiable to employ the injection treatment to allay troublesome symptoms such as pain and bleeding, and thereby make the life of the patient more comfortable even if permanent cure cannot be attained.

ADVANTAGES AND DISADVANTAGES OF INJECTION TREATMENT

Advantages.

- (1) The patient is not confined to bed and the treatment does not interfere with his work or pastimes.
- (2) No anæsthetic is necessary.
- (3) It often produces immediate relief of symptoms, especially of pain and bleeding.
- (4) It is economical in time and money.
- (5) Hospital patients can be treated in the out-patients' departments, so that hospital beds are available for more serious conditions.
- (6) Complications and pain are few and infrequent, whereas after operation the reverse is the case.
- (7) Recurrence. Piles may recur after injection treatment as well as after operation. Recurrence will obviously depend upon the adequacy of the treatment given as well as on the removal of the original cause of the condition. Patients will more readily undergo a second course of injection treatment than a second operation.

Disadvantages.

- (1) Complications, such as abscess formation and sloughing of the rectal wall, may occur unless the correct technique is rigidly followed.

- (2) Fissure in ano. If the proctoscope is introduced too forcibly towards the termination of the treatment, when the passage, owing to the injections, has temporarily become narrowed and the submucosa sclerosed, a posterior anal fissure is apt to result.

END-RESULTS

The results, both immediate and late, of injection treatment in suitable cases are so gratifying that it should be considered the treatment of choice in all cases, except where the contra-indications already mentioned exist.

Gabriel writes as follows: "The most suitable cases for injection are soft prolapsing or vascular piles; these can be promised rapid relief from symptoms, and, in fact, a cure that increasing experience with the method makes one believe will be as permanent, or even more so, as that offered by operation."

Also: "There is no doubt in my mind that the immediate results of this injection method are extremely good, both in the relief of symptoms (bleeding, prolapse, and sometimes discharge) and in actual visible improvements, as shown by proctoscopy. Whether the results will be as permanent as those after operation, time will show. We all know that hæmorrhoid cases do recur after operation. There will doubtless be an occasional relapse also after injection. The sclerosis produced by the 5 per cent solution of phenol in oil is, however, extraordinarily firm and lasting, and the method appeals to me as being sensible, practical and efficient. My belief is that if this method is applied carefully and with good judgment to the right cases by the giving of adequate doses at the correct level and depth, the treatment will be recognised as valuable and proper, with a more extended range of usefulness than that ever afforded by the older methods."

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SECTION 3

HYDROCELE AND VARICOCELE

by
RODNEY MAINGOT

THE INJECTION TREATMENT OF HYDROCELE

THERE are three methods of treating a hydrocele :

- (1) By operation (see page 3056).
- (2) By repeatedappings.
- (3) By the injection of a sclerosing solution into the sac after the withdrawal of the fluid.

This treatment is over a hundred years old. In the past numerous solutions have been used, such as equal parts of carbolic acid and glycerine, tincture of iodine, alcohol in varying strengths, and many other sclerosing solutions, including some in vogue to-day.

The treatment consists in the withdrawal of the hydrocele fluid by means of a trocar and cannula, and the introduction into the sac of a sclerosing solution sufficiently irritating to produce an aseptic, inflammatory reaction of the whole serous lining. This reaction eventually causes the opposing walls to adhere firmly, with the result that the sac is obliterated by fibrous tissue.

TECHNIQUE

(1) Position of the patient. It is best to have the patient lying upon a couch, as this position is comfortable and is also convenient to the operator. The legs should be slightly separated.

(2) Before the injection is undertaken, the hydrocele is transilluminated in order to select the most suitable site for the puncture.

(3) The trocar and cannula (fig. 1849) is taken in the right hand and introduced high into the sac by a firm sudden thrust. When it is felt that the trocar and cannula is well placed, the finger-piece is firmly grasped

between the thumb and index finger of the left hand, and the trocar is withdrawn. It is very important to make quite sure that the cannula remains constantly in the same position when the trocar is withdrawn, both during the evacuation of the fluid, and whilst the sclerosing solution is being introduced. As illustrated, the finger-piece of the instrument permits of a firm grip.

The end of the cannula is held over a large glass flask, and all the fluid removed is collected, measured, and, if necessary, examined microscopically and chemically. The total amount of fluid withdrawn and also its physical characteristics should be noted. The fluid from a hydrocele will be yellow or straw-coloured; that from a spermatocele will be colourless, very slightly milky, or opalescent.

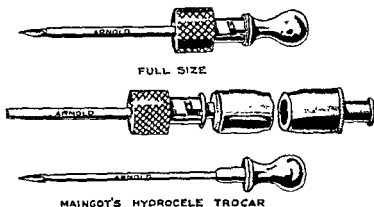


Fig. 1849.—CANNULA AND TROCAR AS DESCRIBED IN TEXT.

A local anæsthetic is unnecessary as the prick produced by the trocar is no more painful than that of the hypodermic needle used when anæsthetising the parts.

Before the sclerosing solution is injected, the operator should be positive that no more fluid remains in the sac.

(4) Sclerosing solutions. I have used a large number of these in varying strengths and dosage, and would advise, in order of preference, the following solutions and doses:

- (a) Quinine-urethane, 8 cc.
- (b) Quinine-urethane, 5 cc., immediately followed by lithocaine, 5 cc.
- (c) Lithocaine, 8 cc.

A 10 cc. syringe is charged with 8 cc. of quinine-urethane and connected to the cannula by a specially-designed rubber tube (see fig. 1849). This permits of some flexibility during the introduction of the fluid. The solution is rapidly introduced into the sac, the cannula

is withdrawn, and the puncture spot sealed off with collodion, after which the scrotum is thoroughly massaged for a short while. After this the patient rests for four or five minutes. A scrotal support may be applied, but this is not essential. He is then discharged and is told to report again in a week's time.

EFFECTS AND RESULTS

The actual introduction of the trocar and cannula causes only slight pain of a momentary nature, but the injection itself may produce a smarting, tingling pain; more often than not, however, the patient experiences no unpleasant sensation. On the night of the injection, and possibly during the next day, the affected side may be tender and slightly swollen. The pain may radiate upwards to the inguinal region, but in a number of patients even this degree of pain is absent. During the first two or three weeks after the injection there may be an appreciable swelling on the affected side of the scrotum, and the hydrocele may feel hard and somewhat tender.

If the sac is aspirated with a No. 16 needle attached to a 10 cc. syringe, sanious fluid will be withdrawn; but it is very doubtful if this aspiration is necessary or an important factor in expediting the process of fibrosis. A re-accumulation of fluid will often suggest to the novice that the treatment has failed, and may lead him to undertake a repetition of the procedure already described; whereas it is only a question of time (4-8 weeks) before this fresh collection of fluid is gradually absorbed, causing the tumour to become smaller and harder, and eventually to disappear so completely that it is often quite impossible to detect on which side the hydrocele originally existed.

Although success may be apparent within a short while, the treatment cannot be said to have failed unless the scrotal tumour is still present after a lapse of more than three months, as a sudden, surprising re-absorption may take place as late as six or seven weeks after injection.

A second or even a third aspiration and injection are necessary in some cases, particularly where the hydrocele is of many years' standing, where its walls are rigid and hard, or where previous tapping has led to the production of a hæmatocele.

Where there is a bilateral hydrocele or a hydrocele complicated by the presence of a spermatocele, the aspiration and injection of each can be undertaken seriatim at one attendance.

The late results are exceedingly good. Up to the end of 1935 I had treated forty-five cases, three of which were regarded as failures.

Two of these failures were subsequently operated upon. At operation, conditions suggested that if another aspiration and injection had been undertaken a complete cure would have resulted without necessity for recourse to operative interference.

In 1933 twenty-nine cases were treated by me or under my supervision at the Southend General Hospital. Six of these were cases of bilateral hydrocele; seven of the single cases and one bilateral case required more than one injection. An examination of all these cases, made in February 1934, showed each of them to be apparently cured with very satisfactory results. I have recently examined ten cases treated over four years ago by the injection method, and each of these can be pronounced cured. In most cases it is quite impossible to detect, even on the closest examination, which side had received treatment.

A hydrocele of the cord is very easily cured by the injection treatment following the method described above.

CAUSES OF FAILURE

These may be summarised as follows:

(1) Incomplete evacuation of the hydrocele fluid. By leaving a quantity of fluid in the sac the sclerosing solution becomes diluted.

(2) A loculus may remain untapped.

(3) An insufficient quantity or an unsuitable sclerosing solution is used.

(4) The sclerosing agent is too irritant or corrosive. A number of serious mishaps have taken place through the injection of pure carbolic or carbolic and glycerine into a hydrocele sac. Sloughing of a portion of the scrotum, necrosis of the testicle or cord, or a severe, intense, brawny inguino-scrotal swelling, associated with considerable pain, and lasting for many weeks, leading to atrophy of the testicle, have been recorded.

THE INJECTION TREATMENT OF SPERMATOCELE

Spermatoceles are usually single and unilateral. Occasionally they are multiple, when they are often bilateral also. *The majority of the single variety are traumatic in origin.* When single and very large, they may be impossible to distinguish from a hydrocele until they have been tapped. When small, however, they are usually found springing from the region of the globus major, and perched upon the top of the

testicle which is displaced downwards and often caused to lie transversely. These small single spermatoceles may be mistaken for a "second testicle" or a hydrocele of the cord.

The treatment of multiple spermatoceles is palliative or surgical, but the injection method, as outlined above for hydrocele, is successful in the cure of the single variety. Even here two or three injections are frequently necessary before a cure is effected.

I have treated 12 such cases by the injection method. Of these, 11 may be regarded as being cured, one for a period of over six years, and 5 for over five years. One was treated only a few weeks ago, and although this case gives good promise it is, as yet, too early to express any definite opinion as to a permanent cure.

THE INJECTION TREATMENT OF VARICOCELE

The majority of cases of varicocele require no special treatment, except perhaps a scrotal support. In advanced cases, in those associated with a constant neuralgia of the testicle, or where the condition occurs in those desiring to enter the Services, there is a choice of operation or injection treatment. Operation will be successful in 80 per cent of cases, but there are three drawbacks:

(1) A secondary hydrocele may develop after operation, requiring a further operation or injection treatment.

(2) The recurrence-rate—20 per cent—is not negligible.

(3) If the operation is not skilfully performed, atrophy of the testicle may result.

Injection treatment for this condition is comparatively recent, and has only been practised by a very few surgeons in this country. When undertaken by one skilled in the treatment the results far exceed those obtained by operation. The advantages, too, are obvious. Usually one treatment, occupying very little time, will suffice to effect a cure. At the most the patient will be incapacitated for two or three days, instead of three or four weeks as in the case of operation.

TECHNIQUE

The patient should stand, or lie upon a table in the reversed Trendelenburg position. After shaving the inguino-scrotal region on the affected side, the parts are prepared as for operation. The skin is painted with alcohol or surgical spirit, and a small area below the external ring

in the region of the anterior surface of the scrotum is anæsthetised with a local infiltration of 1 per cent novocaine with adrenalin.

This area of skin, together with the cord, is picked up and steadied by the thumb and index finger of the left hand. A large vein, seen or felt, is selected for injection. Using the finest and sharpest hypodermic needle affixed to a 5 cc. Record syringe charged with 4 cc. of quinine-urethane or 4 cc. of lithocaine, the vein is pierced, blood is aspirated into the syringe to ensure that the needle is within the lumen of the vein, and the solution is slowly and steadily introduced.

The puncture spot is sealed off with a strip of elastoplast or a collodion dressing, and the patient is told to remain in the same position for about ten minutes before he is dismissed.

The most difficult part of this treatment is the introduction of the needle into the vein, and it may even be impossible owing to the small size of the thin-walled veins or to their complicated plexiform arrangement. It will therefore be necessary in a large proportion of cases to cut down on a vein and isolate it before the injection can be carried out. A stitch or two will be necessary to close this skin wound.

When undertaking the injection it is most important to introduce a large amount (about 4 cc.) of a strong and efficient sclerosing solution, as further injections may prove impossible owing to the partial clotting which may result from this first injection.

The introduction of the solution into the vein may produce severe pain, either in the testicle or radiating up the inguinal canal. This pain is sometimes described as burning or smarting, but occasionally the process is entirely painless.

Within forty-eight hours the entire pampiniform plexus and its leading tributaries are completely blocked with blood clot, and can be felt as a boggy, tender mass occupying the upper two-thirds of the scrotum, and extending to the region of the external abdominal ring. The inguinal canal on the affected side may be tender to the touch. This inflamed mass of veins may be exceedingly painful for a few days, necessitating the patient's going to bed and being given morphia. After the third or fourth day, however, the pain gradually subsides, the œdema becomes less, and the thrombosed veins begin to contract. At the end of a few weeks the cure will be complete, and the former mass of worm-like and tortuous veins is replaced by a few stringy and attenuated threads.

SECTION 4

THE INJECTION TREATMENT OF VARICOSE VEINS

by

R. SIMPSON HARVEY

THE treatment of varicose veins by injection methods was first advocated and practised by Pravtz in 1851, when he used ferric chloride solution, but the complications and disasters were so numerous that the method fell into disrepute. In 1911 Luise in Germany became interested in the obliteration of veins by mercuric chloride during anti-syphilitic therapy, while quite independently Sicard of Paris and his associates, Paraf and Forestier, were working with sodium salicylate.

With improved technique and with investigators trying out a large number of different solutions, better results were obtained. When Génévrier introduced his now famous quinine-urethane mixture and obtained brilliant and permanent results, the method became popular throughout the world.

In recent years the use of injection therapy has been extended to the cure of pathological conditions other than varicose veins, such as hæmorrhoids, hydroceles, bursæ, varicoceles, herniæ, etc. It is hoped that the details given in this section may serve as a practical guide to those interested in and desirous of practising injection therapy.

A thorough and systematic overhaul of the patient should invariably be carried out before any injections are performed, and the liver, kidneys, pelvic organs and heart should receive special attention. Urine tests should be carefully made for any signs of diabetes or nephritis, which, if found to be present, would prohibit the treatment. Even where varicose veins appear to be limited to one particular area in the leg, the whole of both limbs should be inspected. In suspicious cases of ulcer the Wassermann reaction should be taken.

CONTRA-INDICATIONS TO THE INJECTION TREATMENT

(1) *Deep thrombosis*—such as occurs after “white leg.” There is usually a history to guide one, but the leg may feel “brawny” owing to œdema of the deep tissues, and be larger in circumference than its fellow. Here the enlarged superficial veins are compensatory and should not be interfered with. In such cases several months’ treatment with elastoplast bandages to reduce the œdema, and the subsequent wearing of a crêpe bandage or elastic stocking, is all the treatment recommended.

(2) *Phlebitis*. No injection should be given when there is a history of recurrent phlebitis, or within a period of six months of a single attack.

The views here expressed under “deep thrombosis” and “phlebitis” are not, however, generally accepted. A. Dickson Wright (1933), who is an authority on this subject, in a very convincing article in the *Lancet* summarises his views as follows :

“The question of the injection treatment in patients who have suffered from phlebitis is a very vexed one. Firstly, in the case of obliteration of the femoral vein it is said that if you inject the varicose veins which develop many years after the disease you will rob the patient of the only veins that he has left. I have repeatedly found that this is not the case, and have come to the conclusion that these veins constitute an increased embarrassment to the venous return and their blocking by injection reduces the œdema instead of increasing it, and helps to stave off the complications which arise from prolonged vascular imbalance in the legs.

“Secondly, the occurrence of an attack of phlebitis in varicose veins is regarded by some as an absolute contra-indication to any sclerosing injections ; others say that an interval of from one to five years must elapse before any injections are given. It is said that these cases are liable to fatal embolism and acute ascending phlebitis if injected. So it results that most of these cases are allowed to remain in possession of varicose veins which become the seat of constantly recurring attacks of phlebitis with all their attendant pain, anxiety, expense and risk. I have in a large number of cases ignored the history of recent superficial phlebitis, dealing with the varicose veins by injections, and have had no case of embolism. I have had several cases of excessive inflammatory response from the injection, but this can be very satisfactorily controlled if treatment by firm strapping is instituted.”

And again, with regard to the treatment of superficial phlebitis, he writes :

" Treatment of superficial phlebitis is a different problem because the clot can be prevented from travelling upwards by a rubber pad placed at its upper end, and the inflamed vein firmly compressed by a tight elastoplast bandage below the pad. This tight bandaging seems a very painful process to the onlooker, but the rapid disappearance of the pain is most gratifying to the patient. The tight bandage expels the inflammatory exudates around and in the vein, compresses the clot and hastens its organisation. The patient is kept ambulant, even when there is a temperature, and this is generally gone in 48 hours by this method. When phlebitis occurs in varicose veins, keeping the patient up lessens the risk of embolism, because the current of blood is downwards in these veins. Moreover, the tortuosity and uneven calibre of the clots is a further safeguard against dislodgment. Putting the patient to bed with an unsupported leg may lead to extension of thrombosis to the deep veins, with great risk of embolism. The bandage is kept on from two to six weeks, provided it stays in position and keeps tight. If, on its removal, some of the thrombosed veins are found to fluctuate, a stout needle should be inserted, the contents withdrawn, and the bandage reapplied. This hastens resolution and the contents can be examined bacteriologically, so as to make an early diagnosis should suppuration be developing.

" After six weeks of the bandage the venous indurations will be found to be practically gone, and the attack of phlebitis a boon to the patient, in that the veins are obliterated and will not recanalise because of the pressure to which they have been subjected. I have treated many cases who have experienced in previous attacks the routine of six weeks in bed with belladonna or ichthyol locally, and I have not found one patient who preferred this latter method of treatment. There is no place for proximal ligation of veins in simple phlebitis of superficial veins as there is in suppurative phlebitis. I have found that the most certain way of producing phlebitis in a superficial vein of the leg is to ligature it. Proximal ligation only produces a fresh thrombosis, and if done close to the saphenous opening, the clot above the ligature may extend to the femoral vein.

" I have been unable to comprehend the scientific basis of the elaborate ritual of spa treatment in the management of phlebitis, and cannot understand the value of the various glandular extracts and ferments in the treatment of a purely inflammatory disease. This compression treatment is also of the greatest value when an injection

of sclerosing fluid produces an excessive reaction or the dreaded ascending phlebitis. It is also the best treatment when the sloughing of the vein wall occurs or necrosis of the tissues at the point of injection. If the leg is swathed tightly in an elastoplast bandage at the first sign of a necrosis and this is left on for a month or more the slough discharges itself, and the resulting ulcer epithelialises all unknown to the patient, who is thus saved much anxiety.

"The condition of *periphlebitis* is often mistaken for true phlebitis. It occurs only in association with varicose veins and in the lower two-thirds of the leg. It is best described as a non-suppurative cellulitis of the perivenous tissues. It is a very painful condition, and the vein can generally be felt to be patent as it traverses the tender indurated affected area. The treatment is the same as for phlebitis except that the condition is no contra-indication to immediate injection of the varicose veins which should invariably be carried out. The condition of *periphlebitis* often leads to ulceration, the resulting ulcer being sometimes known as a 'phlebitic' ulcer."

Wright then summarises as follows :

"(a) Phlebitis is often a decubitus complication and can be, to a certain extent, prevented by attention to certain details. (b) Superficial phlebitis may be the first sign of three diseases: thrombo-angitis obliterans, cancer of the stomach, and thrombo-phlebitis migrans. (c) Phlebitis is a common complication of varicose veins. (d) The treatment of phlebitis in deep and superficial veins is essentially different. In superficial veins, and especially in varicose veins, the risk of embolism and extension of the phlebitis is reduced by keeping the patient ambulant, and the resolution of the inflammation is hastened by compression. (e) Past femoral thrombosis is not a contra-indication to the injection of obvious varicose veins. (f) Varicose veins, the seat of repeated phlebitic attacks, should be dealt with by injection."

The treatment of post-operative thrombosis is described on page 1258.

(3) *Advanced cardiac, pulmonary or renal disease, and diabetes.*

(4) *Marked cirrhosis of the liver.*

(5) *General skin infection of the legs.* In such cases treatment should not be undertaken till the skin condition has been successfully treated.

(6) *During pregnancy.* Most authorities state that varicose veins should not be injected during pregnancy, and suggest that quinine injections in particular should never be given to a pregnant woman.

R. Greene, however, believes this to be an exaggerated fear and has treated many such cases with quinine-urethane. I, also, have treated a number of pregnant women when the severity of their varicose veins was causing pain and discomfort, and have had no untoward results. The objection is not that the injection may cause harm to the mother or foetus, but that, should the patient after labour develop "white leg" with thrombosis of the deep veins, the superficial veins will be needed. If many veins have been blocked, then severe and troublesome swelling of the foot and leg will result. For large veins I employ the twin injection, which will be described later, where the quinine is precipitated and cannot possibly cause any cinchonism. One or two injections will usually sclerose all but the smaller veins and these will subside after parturition.

SOLUTIONS

Of all the solutions which have been tried, and they number more than a hundred, only quinine-urethane and lithocaine can be recommended to give good permanent results in large veins, but other solutions may be useful in dealing with small, superficial veins.

(1) *Quinine-urethane*. This was introduced by G  n  vri  r and is composed of quinine hydrochloride 4 grammes, urethane 2 grammes, distilled water 30 cc. It was first used in England by Douthwaite and is still recommended by him as being the best sclerosing fluid. It has certain disadvantages in that many patients have an idiosyncrasy to quinine and develop cinchonism after its injection. Every patient should therefore be tested for this before being treated, either by the injection of $\frac{1}{4}$ cc. before proceeding with the larger doses, or by making a cutaneous test by placing one drop of 1 per cent quinine hydrochloride on the patient's forearm and scarifying the skin under it. Sterile water is used for a control. When sensitiveness exists, a definite wheal surrounded by a zone of erythema appears ten minutes later.

It is unwise to inject more than 3 cc. of quinine-urethane into a vein at any one sitting, otherwise untoward symptoms such as giddiness, syncope, etc., are apt to develop. When used by itself quinine is a well-known abortifacient, and it may produce abortion in cases of early pregnancy, or cause hypogastric pain in women who are menstruating.

(2) *Lithium salicylate 30 per cent, tutocaine 1 per cent (known as lithocaine)*. This was introduced by Maingot, who says: "This, in my opinion, is the best solution, and can be recommended for the majority

of cases. It has been in constant use at the Varicose Vein Clinic at the Royal Waterloo Hospital (where upwards of 2000 injections are given every year) since 1926." It must be kept in iron-free bottles, and is put up in iron-free ampoules and rubber-capped bottles by Messrs. Crookes. It is painless on injection, and produces a very hard, firm, extensive clot. 4 cc. is the usual amount recommended for the first injection, but up to 16 cc. have been injected at one sitting.

(3) *Salt solution 20 per cent, tutocaine 1 per cent.* This is a useful solution for small superficial veins, but is useless for large veins in which it produces no effect. 8-10 cc. is the usual amount injected.

(4) *Sodium morrhuate—5 per cent or 10 per cent.* The immediate results with this solution are good. There is very little local reaction after injection, clotting is rapid and often appears after a few minutes, and injection ulcer—the bugbear of all injection therapy—is not likely to occur. The dose recommended is 2-15 cc. A large number of veins in the legs can thus be treated at one sitting. The disadvantages of the solution are that in a large number of cases—30 per cent according to Maingot—there is recurrence by recanalisation owing to the resultant clot being soft and friable. The solution is therefore not to be recommended for large veins. Five per cent of cases develop urticaria a few minutes after the injection of a large dose. It is, however, a very useful solution to employ for the treatment of superficial "spider" veins by the "froth" method, which will be described later.

(5) *Twin injection.* For large cavernous veins there is nothing to equal the twin injection. It consists of injecting simultaneously into the same vein, at a distance of about 2 inches apart, 3 cc. each of quinine-urethane and lithocaine solutions from two syringes. With dexterity this can be performed by one operator using a syringe in each hand, but it is safer for the injections to be undertaken by two operators, using a syringe each.

The patient should be lying down and the injection made at the highest part of the big vein, the lithocaine injection being uppermost. When the two solutions come into contact with each other there is produced a white, stringy, glutinous precipitate of insoluble quinine salicylate. This attaches itself firmly to the walls of the vein and an exceedingly hard and extensive thrombosis occurs. There is no danger of cinchonism as the quinine is precipitated and fixed. In many thousands of cases treated by this method a satisfactory thrombosis has invariably resulted without any unpleasant sequelæ.

Recently I have been performing the twin injection by myself as follows: Three syringes are required. The first, a 5 cc., containing the lithocaine, is attached to the needle and the injection into the vein is made in the ordinary way. The needle is left in the vein and the syringe detached. A second syringe—a 1 cc. hypodermic—containing distilled water, is attached to the needle and a few minims are injected to wash the lithocaine solution out of the needle. This syringe is in turn detached and a 5 cc. syringe, containing the quinine solution, is attached to the needle and its contents injected into the vein. The needle is then withdrawn. Unless performed in this way the needle may clog. Some dexterity of manipulation is needed, and great care must be taken to keep the needle steady during the whole operation so that it does not slip out of the vein. This technique has been employed by me with complete success in the treatment of large veins, and is the one I would strongly recommend for such cases.

TECHNIQUE

Syringe and needle. An ordinary 5 cc. Record syringe is recommended for all injections, and rustless No. 16 needles. The syringe can be sterilised by immersion in spirit, but in this case it is well to rinse it in sterile water before use.

Needles must be sharp. Even the points of new needles, if examined by a magnifying glass, may be seen to be ragged, turned or blunt. If such be used to pierce a thin-walled vein, a tear in the wall results and extravasation of blood mixed with sclerosing fluid is apt to occur, with the possible result of a "leak ulcer" or a painful subcutaneous induration. Moreover, if the vein is thin-walled and lies in loose areolar tissue, its lumen can only be entered successfully if the needle is very sharp. A blunt needle may push the vein wall in front of it, the vein may flatten, and the needle transfix the whole vein instead of entering the lumen.

Needles can easily be sharpened by the following method: Hold a small medicine cork between the left thumb and forefinger with the upper side horizontal; take the

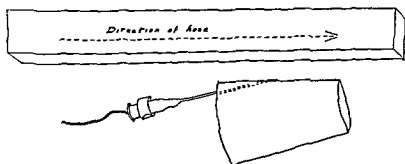


Fig. 1850.—METHOD OF SHARPENING HYPODERMIC NEEDLE. THE DIAGRAM SHOWS THE NEEDLE WHICH HAS PIERCED THE CORK, AND THE DIRECTION IN WHICH THE POINT IS TO BE SHARPENED.

needle in the right hand with the bevel uppermost and tilt it till the bevel is also horizontal. Pierce the end of the cork and drive the needle through till the bevel appears on the upper side of the cork. A brass stylet wire should then be introduced into the needle till its end just emerges. Next, draw a fine honing stone several times along the bevel towards the point to produce a clean, flat bevel. Then turn the needle through 90 degrees and repeat the honing lightly on the side of the bevel. Turn the needle back 180 degrees and repeat the honing on the other side of the bevel. Examine the point through a pocket microscope or strong lens and repeat the honing, either on the bevel or on the sides, till a perfect "stake" point is attained.

Such a needle will pierce skin and vein wall with ease, and will be appreciated by both operator and patient. Needles regularly sharpened in this manner will last for many months; moreover, a short bevel can be produced without sacrificing the sharpness of the point, thus making the injection safer. The shaft should be kept polished and free from roughness by using the finest emery paper obtainable. The object of keeping the wire stylet in the needle during the honing process is to prevent burring and to keep the lumen free.

No vein is too big or too small to be successfully treated by injection, provided that the right technique is employed. For very large veins I employ the twin injection described above. In many thousands of cases of twin injections performed privately and at the Royal Waterloo Hospital Clinic I have never seen any untoward systemic or local symptoms, or failed to produce a lasting thrombosis, however large the vein. I recommend it as the routine method of choice for all large veins.

Excision of a portion of the vein, as advocated by Dickson Wright, yields splendid results, but takes longer to perform and necessitates a certain amount of surgical skill. In many cases a *single* twin injection has produced such an extensive thrombosis as entirely to cure an advanced case of varicose veins.

Medium-sized veins. For all medium-sized veins the sclerosing fluid of choice is lithocaine. Not less than 4 cc. should be injected and this amount may be considerably increased if necessary.

Small veins, especially those that are very near the surface and look as if they might burst at any time, are best treated with sodium morrhuate. Here the venous pressure is very low and recanalisation is unlikely. Moreover, these veins being so near the surface, leakage is very apt to occur through the needle track. Sodium morrhuate is less likely to cause an ulcer than most sclerosing fluids. The amount to be injected varies with the size of the vein, but 2-3 cc. should suffice.

Small "spider" veins, which give rise to no disability but which may require treatment because of their unsightliness, are best dealt

with by the "froth" method. A small No. 20 needle is employed. One cc. of sodium morrhuate is drawn into a 5 cc. syringe, the plunger is withdrawn to the 4 cc. or 5 cc. mark and the solution shaken vigorously. The syringe becomes filled with froth. The skin is then pierced about 1 cm. from the base of the fan-shaped collection of veins, and the point of the needle is worked close under the skin into one of the veins. The point can often be seen under the skin, and slight pressure upon it or rotation of the needle will cause it to enter the vein. The plunger of the syringe is gently pressed, and if the vein has been entered bubbles of froth will be seen coursing along the "spider" veins. The blood is driven out and the lumen of the veins bathed with sodium morrhuate froth. The results are usually excellent, but care must be taken not to inject solution into the subcutaneous tissue or a troublesome ulcer will result, even with sodium morrhuate.

Site of injection. In all cases the first injection should be given at the highest limit of the varicosity, whether in the thigh or below the knee. Where the case is complicated by an ulcer it is usual to inject the veins before applying treatment to the ulcer. In many cases there will be œdema of the leg, and the varicose veins cannot be seen but can be felt as "soggy" linear depressions. Often the treatment of a long-standing ulcer will prove unavailing until these veins have been dealt with by injection, after which healing is rapid.

Position of the patient. Where possible the sitting position is best. *The use of a tourniquet is unnecessary.* For very large veins in which the twin injection is employed the patient should be recumbent or prone upon a couch. This makes it easier for the operator, and, further, in this position the vein is emptied of some of its large quantity of blood. Consequently the injected fluid is less diluted and produces a stronger chemical reaction on the intima of the vein. The recumbent position is also recommended when "spider" veins have to be injected, for here a good light is necessary to watch the passage of the needle point under the skin and into the vein. The standing position should hardly ever be employed, but occasionally it is useful for treating veins on the back of the calf, especially if the patient has had a number of injections and is not nervous.

The injection. The great bogey of the injection treatment of varicose veins is the production of an injection ulcer. This mishap implies bad technique, and is the result of injecting sclerosing fluid into the tissues outside the vein or of the leakage of blood and sclerosing fluid into

of the syringe is grasped between the first and second fingers, and the plunger is driven in with the thumb (fig. 1852).

Some skilled operators prefer to use the fingers of the left hand to hold the skin over the vein steady whilst the right hand controls the

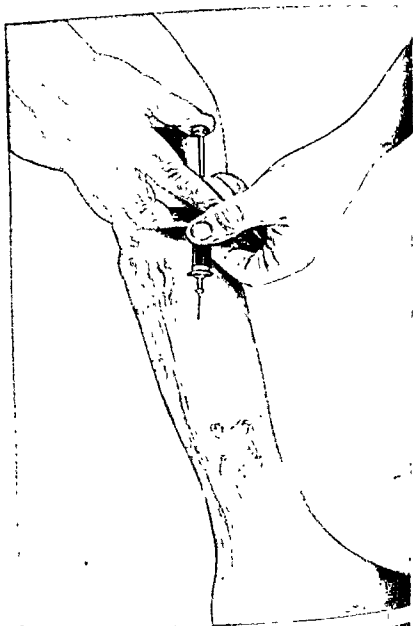


Fig 1852.—THE INJECTION TREATMENT OF VARICOSE VEINS. NOTE THE POSITION OF THE FINGERS OF BOTH HANDS WHILE THE SCLEROSING SOLUTION IS BEING INTRODUCED INTO THE VARICOSE VEIN.

syringe till the vein wall is pierced; but whatever method one golden rule must be observed—"When the point in the lumen of the vein it must be moved in injection has been completed."

with by the "froth" method. A small No. 20 needle is employed. One cc. of sodium morrhuate is drawn into a 5 cc. syringe, the plunger is withdrawn to the 4 cc. or 5 cc. mark and the solution shaken vigorously. The syringe becomes filled with froth. The skin is then pierced about 1 cm. from the base of the fan-shaped collection of veins, and the point of the needle is worked close under the skin into one of the veins. The point can often be seen under the skin, and slight pressure upon it or rotation of the needle will cause it to enter the vein. The plunger of the syringe is gently pressed, and if the vein has been entered bubbles of froth will be seen coursing along the "spider" veins. The blood is driven out and the lumen of the veins bathed with sodium morrhuate froth. The results are usually excellent, but care must be taken not to inject solution into the subcutaneous tissue or a troublesome ulcer will result, even with sodium morrhuate.

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The injection. The great bogey of the injection treatment of varicose veins is the production of an injection ulcer. This mishap implies bad technique, and is the result of injecting sclerosing fluid into the tissues outside the vein or of the leakage of blood and sclerosing fluid into

the tissues through the needle puncture. The former gives rise to a brawny painful induration, and in a few days to the formation of a slough, which later separates, leaving an indolent ulcer which may not heal for three or even six months. The latter gives rise to a small ulcer, 1-2 cm. in diameter, at the site of the skin puncture. It is known as a "leak" ulcer, and will usually heal in a week or two, especially if the clotted blood be evacuated from the underlying vein.

Injection ulcers should at once be strapped over with elastoplast, which is left on for three or four weeks, by which time the slough will have separated. The bandage may then be removed and fresh ones applied at intervals until healing is complete.

Injection ulcers should never occur if due care is taken and the following technique employed :

The syringe should be well washed out with distilled water, filled to the required mark with the injection fluid, the needle fitted firmly, and all air expelled. A few minims of distilled water should next be drawn up into the syringe so as to fill the needle and nipple. This ensures that the needle is free from sclerosing fluid whilst being driven through the skin into the vein.

Having selected the site for injection the skin should be swabbed with spirit, and while it is still wet the finger should be passed over the skin to discover the direction of the vein. This must be felt and visualised, and the needle introduced at an acute angle to the axis of the vein and with the bevel away from it. If there is sound skin and subcutaneous tissue the needle may be introduced directly over the vein. Where the vein is very superficial and the skin is thin, the vein should be approached from the side. If the vein is very large and bulges above the skin, it is better practice to introduce the point a centimetre or so away from the vein and at an angle to it, and to pierce the vein from its deep aspect. By so doing one is less likely to get a "leak" ulcer or a brawny infiltration—the result of a minute leak.

The syringe should be taken in the left hand and held between the thumb and first three fingers, with the thumb half-way along the barrel so as not to obscure the entry of blood into the syringe. With the point of the needle over the selected site of entry, the backs of the fingers of the left hand should be pressed against the patient's leg and the skin of the leg tensed to steady the vein. The grip on the syringe should be light. With the right hand the plunger is held between the thumb and middle finger, whilst the end of the index finger is pressed against the base of the syringe to propel the needle through the skin and to give purchase for the withdrawal of the plunger (fig. 1851).

The skin over the vein is pierced steadily—there must be no stabbing—and a few gentle traction movements are given on the plunger as the vein is approached. The needle can usually be felt to pierce the

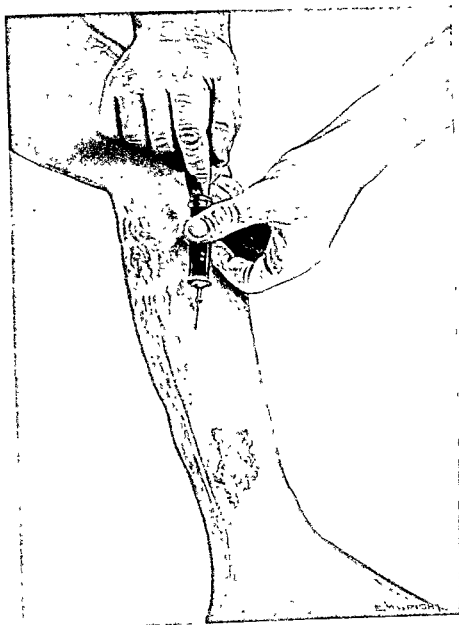


Fig. 1851.—THE INJECTION TREATMENT OF VARICOSE VEINS. THE NEEDLE IS INTRODUCED INTO THE VARICOSE VEIN SELECTED FOR INJECTION, AND A COLUMN OF BLOOD IS WITHDRAWN INTO THE SYRINGE WHICH HAS BEEN PREVIOUSLY LOADED WITH A SUITABLE SOLUTION. NOTE THE POSITION OF THE FINGERS OF BOTH HANDS.

vein wall and then traction on the plunger causes a good head of blood to enter the syringe. Immediately this is seen, the grip of the left hand on the syringe is increased and the fingers are held firmly against the leg so that the point of the needle is steadied and its position in the vein maintained and controlled. The right hand is then removed, the collar

of the syringe is grasped between the first and second fingers, and the plunger is driven in with the thumb (fig. 1852).

Some skilled operators prefer to use the fingers of the left hand to hold the skin over the vein steady whilst the right hand controls the

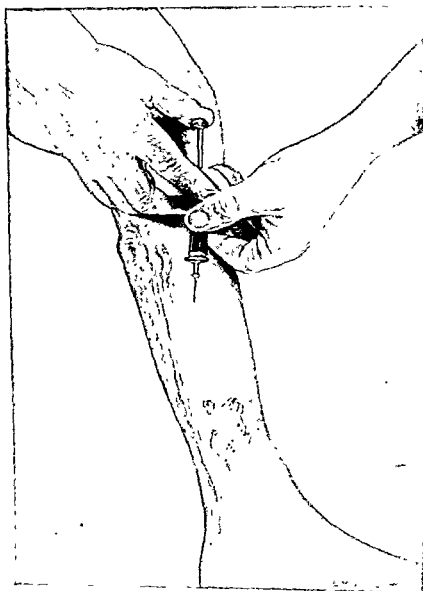


Fig. 1852.—THE INJECTION TREATMENT OF VARICOSE VEINS. NOTE THE POSITION OF THE FINGERS OF BOTH HANDS WHILE THE SCLEROSING SOLUTION IS BEING INTRODUCED INTO THE VARICOSE VEIN.

syringe till the vein wall is pierced ; but whatever method is employed one golden rule must be observed—"When the point of the needle is in the lumen of the vein it must not be moved from its position till the injection has been completed."

If there seems to be any undue resistance to the passage of the fluid, the plunger may be withdrawn a little to see if the blood re-enters the syringe, by which it may be proved that the needle is still in the vein. Failing this the injection should at once be stopped and the needle withdrawn.

After the injection has been made, the needle should be left *in situ* for thirty seconds. The pledget of cotton wool with which the skin has been swabbed is then applied to the puncture site over the needle, the needle is withdrawn, and pressure over the swab is maintained for one minute. If the injection has been made below the knee and the patient is in the sitting position, the leg should be raised for a minute or two to prevent leakage through the puncture.

Some immediate smarting pain may be felt, or there may be a cramp-like pain down the leg. This is due to venospasm. The vein may be seen to contract, or even to produce a sulcus in the skin lasting for fifteen seconds or so. Cases in which venospasm and cramp-like pains occur frequently "take" well, probably because the vein has so emptied itself of blood that the wave of sclerosing fluid is carried down it undiluted and so exerts a stronger effect on its walls. For this reason I inject the fluid as rapidly as possible to try and produce a venospasm and to obtain a maximum concentration of the solution. In some instances it would appear that the resulting thrombosis is proportional to the rapidity of the injection. Rapid injection is not advisable in dealing with very small, thin-walled, or surface veins, with veins which pass across the tibia or tendo Achillis, or with those near the foot. Such veins are apt to swell up and crack when being injected, even if the injection is made slowly. Again, leakage along the needle track may take place, and a very slow rate of injection, followed by firm strapping after hæmostasis is assured, is essential. These veins are the most difficult of all to inject, and the greatest care must be exercised not to transfix them when inserting the needle. Unless the lumen is reached at the first attempt it is better to defer the injection until another occasion.

After making sure that there is no leakage through the puncture site, the skin is dried and a strip of plaster or elastoplast is applied. If there is bleeding at the puncture site, a small hard pad of wool under the plaster will usually control it.

Should there be any misgiving that a little sclerosing fluid has leaked into the tissues, immediate massage and a firm pad and bandage should be employed.

If, in giving an injection, a vein is pierced and then lost, it is better

to defer the injection of that vein and to try another. A patient will forgive a second prick with the needle but will not forgive an injection ulcer.

EFFECTS

Immediately after the injection there may be cramp or a burning pain down the leg, as described above. This only lasts a minute or



FIG. 1853.—A VERY SEVERE CASE OF VARICOSE VEINS OF 35 YEARS' DURATION, AFFECTING CHIEFLY THE INNER ASPECT OF THE LEFT THIGH. THIS PATIENT WAS TREATED BY THE "TWIN" METHOD AT ONE SITTING, NO FURTHER TREATMENT BEING NECESSARY.

so. With lithocaine there is no general reaction, but with quinine-urethane there may sometimes be cinchonism characterised by collapse, giddiness, fainting, nausea, vomiting, hot flushes, palpitation, and hypogastric discomfort or colic. It is for this reason that the use of quinine-urethane has been abandoned at the Royal Waterloo Hospital Clinic except when employed for the twin injection.

Early Effects. In 12-36 hours the injected veins become painful, tender and indurated, showing that thrombosis is taking place. The discomfort is hardly ever sufficient to incapacitate the patient, or to prevent his carrying on his usual occupation. When examined a week later the vein is felt to be hard and slightly tender for a variable distance.



Fig. 1854.—THIS PHOTOGRAPH SHOWS THE RESULT IN THE SAME PATIENT SIX MONTHS LATER. THERE WAS NO SIGN OF RECURRENCE WHEN THIS PATIENT WAS EXAMINED AGAIN SIXTEEN MONTHS LATER.

Late Effects. There is sometimes some discoloration of the skin over the injected vein—a brownish stain—which may last many months, and which in some cases appears to be permanent, especially in dark-complexioned people. The vein itself becomes narrower and harder until it can be felt as a thin cord beneath the skin and may eventually disappear altogether. Recanalisation is sometimes stated to be a common occurrence in veins which have been treated by sclerosing fluids. In a recent article Patey and Tatham state that not only is

recanalisation a frequent event, but that its incidence is unrelated to the nature of the sclerosing fluid employed. This is contrary to our experience. Maingot experimented with over one hundred sclerosing fluids before adopting lithocaine, and came to the conclusion that recanalisation was to be expected in fully one-third of all cases after the use of sodium morrhuate, whether 5 per cent or 10 per cent had been employed. With such solutions as lithocaine and quinine-urethane the clot was definitely harder, fibrosis of the vein being proportionately greater, and the results *permanently* satisfactory in over 90 per cent of cases. I consider that recanalisation or so-called "recurrence" after injection is the outcome of the employment of unsuitable sclerosing solutions, or of bad technique in spacing out the injections. If segments of a varicose vein are left unsclerosed, and especially if these segments communicate with the deep circulation, it is only to be expected that they will resume their varicose nature as soon as the superficial communicating veins restore the traffic of blood through them. Lithocaine, especially when used with quinine-urethane in the twin injection, produces a sclerosis varying from 2-20 inches in extent (figs. 1853 and 1854). In the latter case one injection may be all that is necessary to effect a cure, even in an advanced case. When the resultant thrombosis is of limited extent it is essential to follow the vein up and down the leg with injections till all the varicosities have been sclerosed.

COMPLICATIONS

(1) *Injection ulcer.* The most distressing complication that can arise after injecting a varicose vein is an ulcer at the site of the injection. Ulcers may be of two varieties :

(a) A phlegmonous sloughing ulcer which results from injecting sclerosing fluids into tissues outside the vein ; and

(b) A smaller superficial "leak" ulcer.

Both are due to bad technique—the first during the injection, and the second in the after-treatment.

The first variety should never occur if the method of injection described above is followed. Such a complication has not been observed in the last 2000 injections undertaken by the writer. *Severe pain* during the injection is a warning sign that fluid may have escaped outside the vein. At the first complaint of pain from the patient the injection should be stopped and the plunger be withdrawn to see if blood re-enters the

syringe. If a column of blood does not enter the syringe it is obvious that the point of the needle is outside the vein, in which case the needle should be withdrawn and the part massaged in order to spread and dilute the fluid. The treatment of injection ulcer by strapping with elastoplast has already been described.

A "leak" ulcer is a much less serious affair. It results from necrosis of the punctured track and of a small area of skin around, where blood mixed with sclerosing solution has been allowed to leak and pool in minute amounts under the strapping. Veins covered by thin and atrophic skin should never be injected directly, but always from the side or even from below by piercing the skin a centimetre or so away from the vein, as otherwise leakage is very prone to occur. Great care should be taken to see that bleeding has ceased before the patient is dismissed. "Leak" ulcers are always shallow and small, and heal in one or two weeks under a strip of elastoplast.

(2) *Pulmonary embolism.* The danger of this complication arising after injection is slight, but as the possibility is often much in the mind of the patient *his fears should be allayed before the treatment is undertaken.* The number of cases which develop pulmonary embolism is stated to be very small—less than one case in 50,000. This may be explained in part by the fact that the resulting thrombus is an aseptic one, and tends to adhere firmly to the vein wall, unlike the thrombus of septic phlebitis which is soft and friable. An added reason why such a complication is unlikely to occur is that when the patient is standing erect the blood-flow in the varicose veins is reversed so that should a thrombus become detached it would tend to travel centrifugally rather than centripetally. Safety in this respect will, however, greatly depend upon the selection of suitable cases, as has already been stressed.

(3) *Persistent œdema of the limb.* This is usually the outcome of injections being given in cases where septic phlebitis or deep thrombosis has been overlooked. It is a difficult and intractable complication, and usually necessitates the permanent use of some form of support to the leg, either by an elastic stocking or an elastic bandage as specially designed for this purpose.

(4) *Cellulitis and localised abscess.* Such complications cast serious reflections upon the technique employed by the operator. They are, however, fortunately of rare occurrence.

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SECTION 5

THE TREATMENT OF CHRONIC GRAVITATIONAL ULCERS OF THE LEGS¹

by

A. DICKSON WRIGHT

PRACTICALLY all the ulcers of the lower part of the leg are the result of gravity and can be called gravitational ulcers, and they are a manifestation of decompensation of the venous circulation of the legs from the following causes :

- (1) Varicosity of superficial or deep veins. If of superficial only, the prognosis is better than if both are involved.
- (2) Obliteration of superficial or deep veins by thrombosis.
- (3) Incompetence of the new veins resulting from canalisation of thrombosed veins.

The result is the same whatever the cause, and results in holding up of œdema and katabolites in the leg with resulting reduction in resistance to trauma and infection.

Whatever the cause the treatment is the same, viz., to balance the arterial and venous circulations, and the indication of the accomplishment of this is the abolition of œdema ; once this is obtained the ulcers, eczema and periphlebitic induration will disappear in the most remarkable manner. To simplify treatment, seven grades of ulcer will be considered.

(1) *The indolent abrasion* or burn over the lower part of the leg which refuses to heal although there is no marked varicosity or œdema of the leg. Place a strip of elastoplast loosely over the abrasion and pinch together so as to narrow the ulcer, then secure with another strip of elastoplast and change every four to seven days, when the ulcer will quickly heal (fig. 1855). It is the cessation from dressings which induces the ulcer to heal, not the sticking plaster.

¹ Illustrations by kindness of the Editor, *The Medical Press and Circular*.

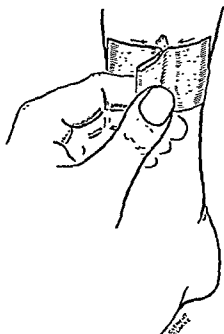


Fig. 1855.—METHOD OF PULLING MARGINS OF ULCER TOGETHER BY FINCHING UP A FOLD OF STICKING PLASTER.

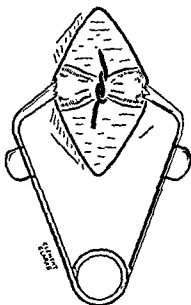


Fig. 1856.—LIGATION OF SAPHENOUS VEIN UNDER LOCAL ANESTHESIA IS DONE IN CASES REFRACTORY TO INJECTION. THIS DOES NOT REQUIRE ANY REST IN BED.

(2) *The small ulcer*, which is located at the lower end of a long system of varicose veins, generally starting at the saphenous opening. The ulcer is clearly the result of this one group of veins, and is not a sign of a generally disordered circulation of the leg. Inject the veins from above down, starting with 5 cc. sodium morrhuate 5 per cent. If no effect is obtained, change to 5 cc. lithocaine solution (30 per cent lithium salicylate and 1 per cent tutocaine), and if this again fails, try simultaneous injection of equal amounts of quinine, 12 per cent, and urethane and lithium salicylate into the same vein. Finally, if this fails, the saphenous vein should be ligated about 6 inches below the saphenous opening (fig. 1856) and injected with 2½ cc. lithocaine solution above and below the ligature. This latter procedure will initiate a prompt thrombosis, and the remaining veins will thrombose readily by subsequent injections at four-day intervals. During the treatment the ulcer below is strapped locally as described previously (fig. 1857). Finally, when the veins are all thrombosed the whole leg from the toes to the knee is firmly strapped (fig. 1858) with elastoplast for fourteen days, and by this procedure the ulcer, if not already healed, will quickly close and the pressure of the elastoplast will cause the venous inflammations resulting from the injections to clear up promptly, leaving the veins as firm painless cords unlikely to recanalise.

(3) *The moderate sized ulcer* of up to four square inches, occurring on a very œdematous leg which has, in all probability, a valvular deficiency of the deep veins as well. Such an ulcer is often the result of a white leg occurring some twelve years previously. It seems to take this period of time for the leg to reach the ulceration stage. One-inch strips of zopla plaster are applied tightly across the ulcer so as to pull the edges together (fig. 1859), and the leg is then tightly bandaged with elastoplast, laying longitudinal strips on the narrow part of the leg (fig. 1860), and finally strapping the leg over these from toes to knee. The strapping is renewed in three days' time, because it becomes loose from the reduction of the œdema. A better plan, of course, is to put the patient to bed for three days with the bed sloped, and then to start strapping while still in bed with the leg shrunk. This is, however, not practicable in hospital work. The strapping is again renewed after four days, with further changes at seven- or fourteen-day intervals. The veins in the thigh are injected each time the bandage is changed. It is not of much value to inject the leg veins at this time, because, as a rule, the injections do not take if the elastoplast

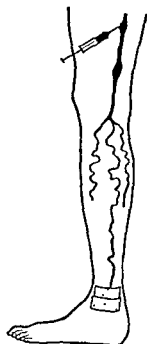


Fig. 1857.—THIS TYPE OF ULCER IS EASILY AND PERMANENTLY HEALED BY INJECTING THE CAUSATIVE VEINS. WHILE INJECTIONS ARE BEING CARRIED OUT, THE EDGES OF THE ULCER ARE PULLED TOGETHER WITH ADHESIVE.

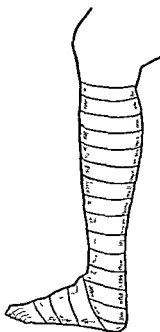


Fig. 1858.—EXTENT AND METHOD OF APPLYING ELASTOPLAST BANDAGE FOR ULCERS AND PHLEBITIS AND POST-INJECTION INDURATION.

is applied over the injected veins. When the ulcer is healed, then the veins in the leg are injected and *ichthopaste bandages* used to support the leg, and it is interesting that the injections seem to take under this type of bandage. The technique of applying these bandages is important. The bandages (two) are warmed in a water bath and applied smoothly from toes to knee. The direction of the bandage should be frequently changed by cutting the bandage and changing hands, the secret being to apply short lengths instead of laying the bandage continuously, as one would do with a roller bandage. The support should be finished off with a firm crêpe bandage, which sticks to the underlying moist bandage and gives an excellent combination of rigid support from the gauze ichthopaste bandage and elastic support from the crêpe. Such a bandage will last anything up to six months, according to the habits of the patient, and then should be changed for another or for a good elastic stocking. The necessity for a permanent support will depend upon two things: the amount of work and standing the patient has to do, and the degree of venous incompetency left after thorough injection of the superficial veins, which will depend upon the existence of previous deep phlebitis and valvular incompetence of the deep veins.

(4) *The very indurated ulcer on a leg solid with unpittable callous œdema resulting from long-standing circulatory imbalance. These cases should receive the tightest possible bandaging, and the most*



Fig. 1859.—SHORT STRIPS OF ADHESIVE APPLIED TIGHTLY OVER THE ULCER TO PULL THE EDGES TOGETHER.

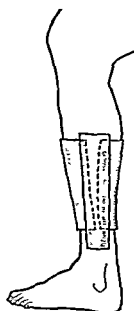


Fig. 1860.—STRIPS APPLIED TO PREVENT SLIPPING AND CUTTING OF SPIRAL ELASTO-PLAST BANDAGE.

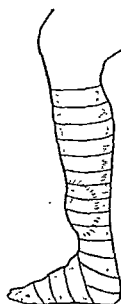


Fig. 1861.—SORBO PAD INCORPORATED IN BANDAGE TO SOFTEN EDGES OF CALLOUS ULCER.

amazing reductions in size can be effected. In addition to the strapping described in Type 3, a piece of sorbo sponge should be incorporated in the bandage over the site of the ulcer (fig. 1861). The sorbo should not be in contact with the ulcer, but separated from it by the short strips of zopla and the longitudinal strips of elastoplast.

(5) *The malleolar ulcer* occurs more commonly not on the malleolus but in the sulcus which surrounds it. This type of ulcer is especially common in cases of old femoral thrombosis, and it frequently develops even when elastic stockings are worn, because the stocking supports every part of the leg but the peri-malleolar depressions. To overcome this I have had special pads made (Down Brothers) to support this

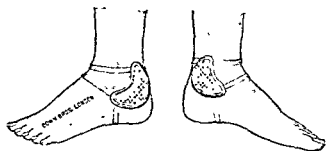


Fig. 1862.—MALLEOLAR PADS WHICH ARE WORN UNDER ELASTIC STOCKINGS TO PREVENT RECURRENT MALLEOLAR ULCERS.

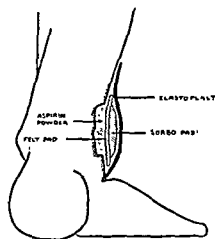


Fig. 1863 (Type G).—METHOD OF TREATING MALLEOLAR ULCER SO THAT FIRM PRESSURE WILL BE AFFORDED TO THE ULCER BED IN SPITE OF THE PROMINENCE OF THE MALLEOLUS.

part of the leg (fig. 1862). These ulcers cause much suffering, and are often known as *irritable ulcers*, the pain frequently being most marked in the area below the ulcer rather than in the ulcer itself; the title describes not only the ulcer but the patient's frame of mind, and these cases need much humouring and coaxing. To lessen the pain, pure amorphous aspirin (not crushed tablets) or percaïne powder may be dusted on, and then the ulcer edges are pulled together with thin strips of adhesive plaster. Over the adhesive plaster is placed a two-inch square of "elephant" plaster (adhesive felt), and over this a one-inch square of "Dunlopillo" $\frac{1}{2}$ inch thick (fig. 1863). Finally, the whole leg is bandaged from toes to knee with a firmness proportional to the cedema. Injections are carried out as before with the greatest thoroughness, and finally an ichthopaste bandage is applied, and then, to consolidate the cure, an elastic stocking, with the malleolar pads. During the early stages of the

treatment recourse must be made to barbiturates and aspirin or codein to get peaceful nights.

(6) *The ulcer occurring in association with extensive eczema.* In these cases one feels nervous about applying elastoplast over such tender skin. It should always be tried, nevertheless, but removed in two days to see if it suits. Fifty per cent of eczematous cases are cured with elastoplast, the other 50 per cent will be cured by the alternatives of "ceraban" or "ichthopaste" bandages. Very thorough injection is essential in eczematous cases, and the application of ung. bism. et quinoline (Stewart), or crude coal tar 1 drachm, zinc oxide 1 drachm, lanolin and vaseline ad one ounce, under alternate bandages is of value.

(7) *Extensive ulcers* of 10 square inches up to the maximum size of 140 square inches. These ulcers always occur on very oedematous legs, and require very firm bandaging or rest in bed at first to reduce the swelling. The profuse discharge leads to sliding of the bandage, so it is necessary in the more extensive ulcers to prevent the possibility of the bandage cutting by the use of elephant plaster rather than the usual longitudinal elastoplast strips (fig. 1864). Skin grafting is of great help in these cases, securing a more rapid healing before the skin gets "sick" of elastoplast. The grafting is done by implanting seeds of skin under the granulations or by sewing skin strips into the granulations (fig. 1865). The grafting does not interfere with ambulatory treatment, and after their use the same bandaging method is used. Again, consolidation of healing is secured with ichthopaste and permanence of cure with thorough injection and elastic stockings, worn for ever if thought necessary in bad cases.

Contra-indication to these lines of treatment is only found in cases where arteritis is also present and the ankle pulses cannot be felt. The principles of treatment should not be abandoned if eczema or blistering occurs under the elastoplast. This dermatitis is of three types :

(1) A simple patchy eczema of a mild type. This can be ignored as a rule and will disappear, especially with tighter application.

(2) A localised area of acute dermatitis round the ulcer, as if the combination of the discharge and the bandage composition excited an acute cutaneous inflammation. This can be dealt with by bandaging the leg with gauze before applying the elastoplast or by laying longitudinal strips of lead adhesive (ceraban) over the raw area. In many cases this dermatitis does not occur under zopla strips.

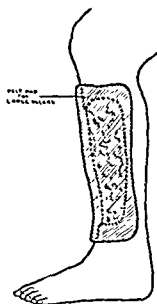


Fig. 1864 (Type 7).—LARGE PAD OF ELEPHANT ADHESIVE FELT TO ENSURE EVEN PRESSURE OF ELASTOPLAST SPIRAL.

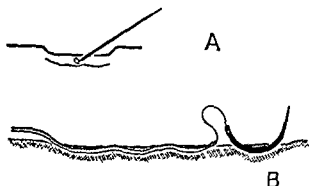


Fig. 1865 (Type 7).—METHODS OF SKIN GRAFTING. A, WITH SKIN SEEDS, OR B, WITH A "WORM" OF LIVING SKIN INSITUATED UNDER THE GRANULATIONS.



Fig. 1866 (Type 7).—MASSIVE ULCER OF THIRTEEN YEARS' DURATION AND MEASURING SEVENTY SQUARE INCHES.



Fig 1867.—THE LEG AFTER TREATMENT. THE SCARS ON THE FOREARM SHOW THE SITE FROM WHICH SKIN GRAFTS WERE OBTAINED, AND THE OUTLINE OF THE GRAFTS CAN BE SEEN ON THE HEALED ULCER, MANY OF THE ISLANDS MEASURING ONE INCH ACROSS, WHEREAS THE GRAFTS MEASURED ONE-EIGHTH OF AN INCH.

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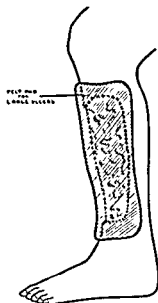


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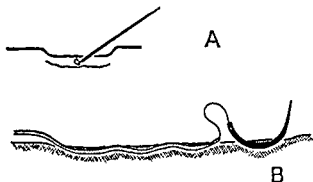


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Fig. 1867.—THE LEG AFTER TREATMENT. THE SCARS ON THE FOREARM SHOW THE SITE FROM WHICH SKIN GRAFTS WERE OBTAINED, AND THE OUTLINE OF THE GRAFTS CAN BE SEEN ON THE HEALED ULCER, MANY OF THE ISLANDS MEASURING ONE INCH ACROSS, WHEREAS THE GRAFTS MEASURED ONE-EIGHTH OF AN INCH.

treatment recourse must be made to barbiturates and a to get peaceful nights.

(6) *The ulcer occurring in association with extensive* these cases one feels nervous about applying elastoplast to tender skin. It should always be tried, nevertheless, for two days to see if it suits. Fifty per cent of eczematous ulcers with elastoplast, the other 50 per cent will be cured by use of "ceraban" or "ichthopaste" bandages. Very little is essential in eczematous cases, and the application of quinoline (Stewart), or crude coal tar 1 drachm, zinc ointment, lanolin and vaseline ad one ounce, under alternate value.

(7) *Extensive ulcers of 10 square inches up to the* of 140 square inches. These ulcers always occur on the legs, and require very firm bandaging or rest in bed to reduce the swelling. The profuse discharge leads to sliding of the bandage so it is necessary in the more extensive ulcers to prevent of the bandage cutting by the use of elephant plaster instead of usual longitudinal elastoplast strips (fig. 1864). Skin grafts help in these cases, securing a more rapid healing by the use of "sick" of elastoplast. The grafting is done by implanting skin under the granulations or by sewing skin strips into the ulcers (fig. 1865). The grafting does not interfere with the treatment, and after their use the same bandaging method of consolidation of healing is secured with ichthopaste. The cure with thorough injection and elastic stockings is thought necessary in bad cases.

Contra-indication to these lines of treatment is where arteritis is also present and the ankle pulses are absent. The principles of treatment should not be abandoned if dermatitis occurs under the elastoplast. This dermatitis is of

(1) A simple patchy eczema of a mild type. This is a rule and will disappear, especially with tighter bandaging.

(2) A localised area of acute dermatitis round the ulcer. This is a combination of the discharge and the bandage causing acute cutaneous inflammation. This can be dealt with by washing the leg with gauze before applying the elastoplast strips of lead adhesive (ceraban) over the ulcer. In these cases this dermatitis does not occur under zoplasma.

(1) *Syphilitic ulcers* frequently occur in the "ulcer area," but are often associated with ulcers below the patella. Anti-syphilitic treatment is, of course, important, but often not sufficient to heal the ulcers because of the gravitational element also present. Encasement in elastoplast saves frequent dressings and makes for rapid healing if combined with the usual therapeutic measures.

(2) *Ulcus serpiginosus* is of two types :

- (a) Soft sore, either by direct extension from the inguinal region, or by secondary implantation from a primary in this region.
- (b) Non-specific serpiginous ulcer closely resembles soft sore, but the organism cannot be found and the patient cannot be suspected of this infection in every case.

A lady of 37 had her left leg amputated six years previously for a serpiginous ulcerative process which had spread from the lower part of the leg to the foot. The eminent surgeon who saw her at that time had said that the arterial supply was inadequate. Now the process had started in the other leg and she was greatly alarmed. The process was the usual one, painful induration appeared under the skin and after two or three weeks broke and formed an ulcer with undermined edges. The ulcer then slowly spread, healing as it went, and when the ulcer seemed on the point of healing an induration would appear on one part of its margin and the same process would start again. The process was readily brought to an end by converting the ulcer into a type which *would* heal by means of the diathermy cautery and then strapping the diathermy burn with elastoplast.

Mycoses of the leg are by no means rare, and they have a very characteristic syndrome and resemble *ulcus serpiginosus*, except that there are numerous ulcers and that they start and recur from a small vesicle or bulla. They cause much pain and œdema, and may last for as long as 25 years. This diagnosis is made on the clinical features, not on laboratory reports for mycelium, which are notoriously unreliable. The treatment with this paint is always effective :

Cignolin 2 grs.
Ol Cade (deodorized) 40 m.
Benzol rect. ad 1 oz.

Carcinoma occasionally supervenes in cases of long-standing ulcer. X-ray shows involvement of the bone and biopsy makes the diagnosis clear. Treatment consists in amputation and inguinal adenectomy.

Bazin's disease. These ulcers occur on the back of the leg, which is cold and blue in young women who have had tuberculosis of the cervical glands. The ulcers come in the winter and disappear in the summer, and therefore cannot be tuberculous. Treatment by elastoplast is satisfactory, but lumbar ganglionectomy gives a permanent cure.

Poliomyelitis ulcers are like those of Bazin's disease, and are best treated by lumbar ganglionectomy.

Splenic ulcers occur round the malleoli in splenic diseases, and get well if the disease is one in which splenectomy does good, e.g. sickle-celled anaemia.

Ulcus tropicus is a spirochætal gangrenous type of ulcer which is more disabling in certain parts of the tropics than even malaria. In its first stages it is a horrible, gangrenous process destroying everything in its path. It is treated in this stage with N.A.B., iodoform powder or hydrogen peroxide. In the second stage the ulcer "smoulders" with small recrudescences at its margins, and in the third stage it is a clean granulating surface which heals very slowly. This last stage is treated as for any chronic ulcer of the leg.

PART XV
INFECTIONS OF THE HAND
by
HAMILTON BAILEY

INFECTIONS OF THE HAND

by

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IN dealing with infections of the hand theoretical knowledge is even more important than practical experience. It is but ten or fifteen years since this subject emerged from an almost chaotic state, thanks largely to the pioneer work of A. B. Kanavel. The need of dissemination of his teaching among that large section of the profession who treat infected hands is still apparent.

PARONYCHIA

Organisms gain entrance through a hang-nail and the tissues about the base of the nail become inflamed. Suppuration follows frequently and in 63 per cent of cases pus accumulates under the nail, as well as beneath the cuticle.

Prophylaxis. Loose tags of skin should be cut off with scissors and the associated fissure sterilised with iodine and kept clean.

Treatment is early operation. Lateral incisions are made (fig. 1868) and the flap is turned back. In order to keep the flap elevated a wisp of gauze soaked in paraffin is inserted under the flap (fig. 1869). In very



Fig. 1868.—PARONYCHIA.—INCISIONS FOR TURNING BACK THE FLAP.

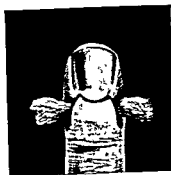


Fig. 1869.—A WISP OF GAUZE SOAKED IN PARAFFIN IS USED TO MAINTAIN ELEVATION OF THE FLAP.



Fig. 1870.—WHEN THERE IS PUS UNDER THE NAIL A PORTION (B) IS REMOVED AND A PORTION (A) RETAINED.

early cases one lateral incision may be sufficient, but it is wise to err on the side of radicalism. Hot moist dressings are applied to the whole finger for 48 hours. After that time local liquid paraffin dressings alone are employed.

When there is pus under the nail. In addition to the above, the base of the nail (fig. 1870) should be removed in the following way: After the flap has been turned down one blade of a pair of scissors is inserted under the base of the nail, and the portion (B) is removed. It is unnecessary and harmful to remove (A) unless it is detached. The portion (A) will exercise a protective action until the new nail grows up and forces it away, a process which takes about two months.

INFECTION OF THE TERMINAL PULP COMPARTMENT

Nearly as common as paronychia is infection of a terminal pulp compartment. The pulps of the fingers and thumb are subjected to more pricks, and therefore infections, than any other part of the hand. Nature has provided in this situation a closed fascial compartment which extends from the tip of the digit to the level of the equine line of the terminal phalanx (fig. 1871).

has been done; in one instance it determined an infection which proved fatal. If tenderness is most marked over the pulp compartment it is permissible to wait for localisation of pus. While waiting, hot saline baths and fomentations are ordered. As soon as tender induration is present a deep hockey-stick shaped incision (fig. 1872) is made into the pulp. *The incision must on no account extend in a proximal direction further than half an inch from the terminal flexor crease.* No drainage material is used. Fomentations are applied for 48 hours, then liquid paraffin dressings are substituted. The wound is irrigated daily with eusol.

In late cases, as soon as the incision is made, the diaphysis of the terminal phalanx literally falls out of a pocket of pus. In earlier cases, the onset of osteomyelitis may be prevented, but this happy event is distinctly rare. Usually, after some days or weeks the diaphysis can be picked out of the wound as a sequestrum. After sequestrectomy the wound heals within a week. It leaves a shortened phalanx with rather an ugly curved nail, but with full functional activity of the digit. In young children regeneration of the diaphysis sometimes occurs. In the interval between the incision and the healing of the wound or the removal of a loose sequestrum a weekly radiograph is desirable (fig. 1873).

For the foregoing lesions local anæsthesia is adequate. A tourniquet in the shape of a fine rubber catheter is tightened about the base of the finger. Above this 1 per cent or 2 per cent novocaine is infiltrated so as to surround the digit. The needle is then passed in deeply in order to block the digital nerves.

Paronychia and infections of the terminal pulp compartment, together with boils on the dorsum of the hand and strictly limited superficial cellulitis, are the only types of infected hand which should be treated in the out-patient department or in the consulting-room. The more serious infections, which we are about to consider, must be admitted urgently and treated as major lesions, for, apart from the danger of metastatic infection, is not a man's hand one of his most valued possessions?

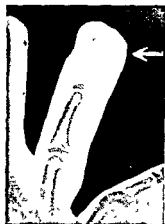


Fig. 1873.—RADIOGRAPH SHOWING NECROSIS OF THE TERMINAL PHALANX. THIS IS A USUAL ACCOMPANIMENT OF INFECTIONS OF THE TERMINAL PULP COMPARTMENT.

SERIOUS INFECTIONS OF THE HAND

When the hand is to any extent seriously inflamed it takes up the position of rest (fig. 1874).



Fig. 1874—THE POSITION OF REST FOR THE HAND (After Wood-Jones.)

Grave infections of the hand fall particularly into three categories :

- (1) Lymphangitis.
- (2) Suppurative tenosynovitis.
- (3) Fascial space infections.

(3) are often a sequel of (2).

LYMPHANGITIS

Organisms, almost always streptococci, gain entrance through an abrasion which may be minute. A portion of the hand immediately adjacent becomes swollen and painful, and there is often considerable elevation of the temperature. Later, red streaks, so characteristic of lymphangitis, can be seen coursing up the arm. It is of cardinal importance to distinguish lymphangitis from suppurative tenosynovitis and fascial space infections. The two latter conditions require urgent operation, while in lymphangitis, at any rate in its early stages, incision is highly mischievous.

SUPPURATIVE TENOSYNOVITIS

If a tendon sheath is infected, that finger is likely to be more flexed than the others. The forefinger when inflamed is not so much flexed as the remainder (J. Hilton). It is of fundamental importance to be able to visualise the surface anatomy of the tendon sheaths and their connections (fig. 1875).

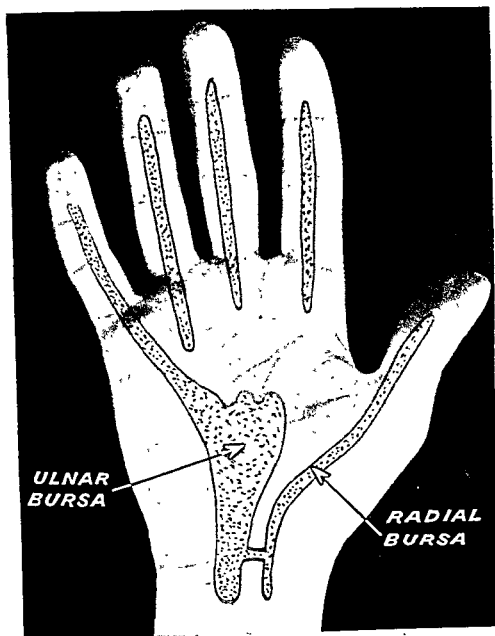


Fig. 1875.—FLEXOR TENDON SHEATHS OF THE HAND.

The essential signs of an infected digital flexor tendon sheath are :

- (1) Swelling of the finger.
- (2) Flexion of the finger with exquisite pain on extension.
- (3) Tenderness, maximally over the infected sheath.

The point of maximal tenderness is found by palpating systematically with some blunt-pointed instrument. A burnt match stalk with the loose charcoal removed answers the purpose admirably.

As the œdema increases, so spontaneous pain decreases. We have seen cases where œdema was so pronounced as to cut off the blood

supply to the digit, gangrene resulting.¹ In suppurative tenosynovitis the back of the hand is particularly œdematous.

This is a convenient point at which to stress a fundamental so important that it should be shouted from the house-tops. The greatest swelling does not indicate the position of the pus. Frequently there is œdema (swelling) of the dorsum (fig. 1876), whereas in 90 per cent of cases the pus lies on the palmar aspect. Œdema gives rise to pitting on pressure. If pus is present, induration of tissues can be felt.

Serious as it is at all times, suppurative tenosynovitis becomes a lesion of the first magnitude when the tendon sheaths of the thumb or the little finger are involved. In the case of the little finger the



Fig 1876.—ŒDEMA OF THE BACK OF THE HAND IS VERY COMMON IN INFECTIONS OF THE PALMAR ASPECT.

ulnar bursa (the palmar bursa of British anatomy) will almost certainly be implicated quickly. If the infection is primarily in the flexor tendon sheath of the thumb the *radial bursa* (syn. sheath of the flexor longus pollicis) must be simultaneously infected along its whole course, that is right up under the anterior annular ligament to above the wrist (see fig. 1875).

Nor is this the whole gloomy story. If the tendon sheath of either the thumb or the little finger becomes infected there is an 80 per cent chance that within 48 hours there will be a total infection of both the ulnar and radial bursæ, for as shown in figure 1875 there is usually an intercommunicating channel between them.

¹ Such cases require immediate disarticulation at the metacarpo-phalangeal joint. When this is done the cut end of the flexor tendon must be stitched to the edge of the wound which is left open. The reason for this is discussed on page 3327.

SIGNS OF INVOLVEMENT OF THE RADIAL BURSA

- (1) Flexion of distal phalanx of the thumb with rigidity.
- (2) Swelling just above the anterior annular ligament.
- (3) Tenderness over the flexor longus pollicis sheath.

SIGNS OF INVOLVEMENT OF THE ULNAR BURSA

- (1) Œdema of the hand, especially the dorsum.
- (2) Fulness of the palm, but the concavity is still present.
- (3) Fulness immediately above the anterior annular ligament.
- (4) Kanavel's sign—the most valuable of all in early cases—a point of maximal tenderness, in the position shown in figure 1877.

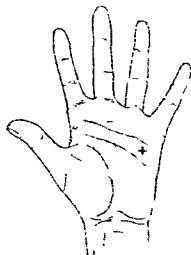


Fig 1877.—KANAVEL'S SIGN FOR ULNAR BURSITIS. MAXIMAL SITE OF TENDERNESSE MARKED WITH A CROSS. THE SIGN PASSES OFF IN A FEW DAYS.



Fig 1878.—SUPPURATIVE TENOSYNOVITIS OF THE MIDDLE FINGER. THE TENDON SHEATH HAS BEEN LAID OPEN.

GENERAL PRINCIPLES IN THE TREATMENT OF SUPPURATIVE TENOSYNOVITIS

Effective drainage must be instituted at the earliest possible moment. Gas and oxygen or evipan anæsthesia is employed. The hand is raised for three minutes and a *tourniquet is applied to the forearm*. The hand is placed upon a small table and the surgeon sits down to operate. The infected tendon sheath should be opened widely (*fig. 1878*), not exactly in the middle line, but somewhat to one side of it. The middle line is avoided in order to prevent, as far as

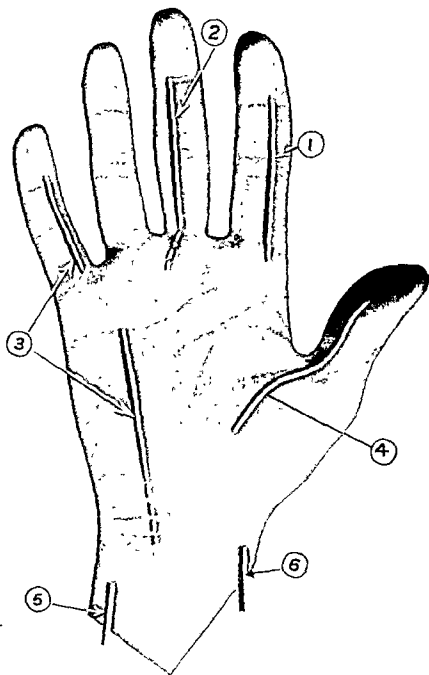


Fig. 1870.

- (1) USUAL INCISION FOR OPENING AN INFECTED FLEXOR TENDON SHEATH.
- (2) WHEN A LUMBRICAL CANAL IS INFECTED IN ADDITION THE INCISION IS PROLONGED INTO THE APPROPRIATE WEB SPACE.
- (3) INCISIONS FOR OPENING AN INFECTED ULNAR BURSA.
- (4) INCISION FOR OPENING AN INFECTED RADIAL BURSA.
- (5) INCISION FOR DRAINING THE FOREARM. (See also Fig. 1881.)
- (6) COUNTER INCISION WHEN THE RADIAL BURSA IS INFECTED. (See also Fig. 1881.)

possible, prolapse of the tendon during the later stage of treatment. In early streptococcal cases there is very little pus within the theca, but the synovial fluid is slightly opalescent or tinged with blood.

A CONSIDERATION OF INDIVIDUAL TENDON SHEATHS FROM THE POINT OF VIEW OF TREATMENT

The index. The sheath should be opened somewhat to the radial side (1, fig. 1879), unless it has been shown at the clinical examination that the lumbrical canal between the index and middle finger is involved. In any case, as soon as the sheath has been opened pressure should be exerted over the second lumbrical canal and over the thenar space; if pus wells out of either of these spaces, it must be drained.

The middle finger. One must decide upon which side to open the sheath so as to be able to drain the appropriate lumbrical canal by a suitable short extension. In doubtful cases the ulnar side is chosen (2, fig. 1879). As soon as the sheath is opened, pressure is exerted over the mid-palmar space, and if pus wells out the space should be drained.

The ring finger. The same principles govern this finger, with the exception that when in doubt the radial side is chosen.

The lumbrical canals concern chiefly infections of the ring, middle and index fingers. These canals act as conducting channels from the fingers to the palm (fig. 1880). A lumbrical canal can be exposed and drained by splitting an interdigital web (see fig. 1887) or, what is often convenient, by extending the incision employed in opening a tendon sheath (see 2, fig. 1879).

The little finger. The sheath is opened on its

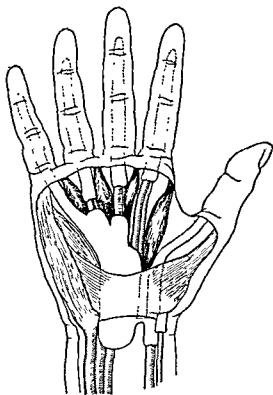


Fig 1880.—DISSECTION SHOWING THE LUMBRICAL MUSCLES. THE LUMBRICAL CANALS PLAY A LARGE PART IN CONDUCTING INFECTION FROM THE TENDON SHEATHS TO THE PALM.

ulnar side; pressure is then exerted over the ulnar bursa. If pus exudes, the ulnar bursa must be opened.

Drainage of the ulnar bursa. The method is important. The hypothenar eminence is inspected; the incision runs down its centre rather near the radial side. It begins at the distal flexor crease, and ends just distal to the first crease encountered at the wrist (3, fig. 1879). A pad of oedematous fat bulges into the wound; this is dissected away. A director is then passed from the sheath of the little finger into the bursa, which is opened along its length as near to the ulnar side as possible. When the anterior annular ligament is reached pressure is exerted above the wrist; pus is usually present here. It is advisable to divide the anterior annular ligament.

The forearm must be drained as described on page 3321. As a general rule, if the infection has been present more than 48 hours there should be no hesitation in opening the radial bursa, which is so often implicated as well.

The thumb. The sheath, opened somewhat on its radial side, is followed through the muscular masses of the thenar eminence (4, fig. 1879). The tendon lies nearer the palm than one is inclined to think. The dissection is carried down towards the wrist until a point *a thumb's breadth above the anterior annular ligament* is reached. The dissection then ceases abruptly, for the motor nerve to the thenar muscle crosses the sheath between this point and the anterior annular ligament. The forearm must be drained as described on page 3321. Once more, as a general rule, if the infection has been present for more than 48 hours there should be no hesitation in opening the ulnar bursa, which is so often infected as well.

Involvement of the forearm from the hand. Kanavel's injection experiments have proved that when bursting of the radial and ulnar bursæ occurs the spread of pus to the forearm passes along the plane between the flexor profundus on the one hand, and the pronator quadratus and interosseous membrane on the other. It is in this deep plane that pus first tracks up the arm, and only late in the course of the disease does it become more superficial. Utilising this knowledge, drainage of the forearm in infections from the hand can be carried out with precision. The styloid process of the ulna is palpated. The

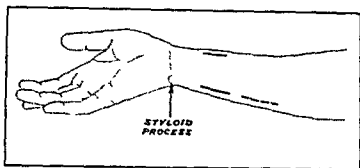


Fig. 1881.—INFECTION OF THE FOREARM FROM THE PALM. INCISIONS FOR DRAINING THE SPACE BENEATH THE FLEXOR TENDONS. THE DOTTED LINE SHOWS THE POSITION OF THE INCISION WHEN IT IS FOUND THAT THE PUS HAS EXTENDED FAR UP THE FOREARM

incision commences $1\frac{1}{2}$ ins. above this point upon the flexor surface of the ulna. The incision is at least 2 ins. long (fig. 1881) and it passes deeply right down to the periosteum. A hæmostat is thrust across the flexor surface beneath the flexor tendons (fig. 1882), and the jaws of the forceps are opened. Next, the proximal extremity of the infected bursa is ruptured thoroughly into the space beneath the flexor tendons. In the case of a radial bursa infection, a counter-incision is made upon the radial side (see fig. 1881). The surgeon's finger is now passed into the incision and the flexor tendons are sought. If the tendons are not at once apparent, flexion and extension of the fingers will reveal them, and the exploring finger passed deep to them comes to lie on the interosseous membrane. In the case of the radial bursa, a hæmostat is passed from the palmar incision until its beak is

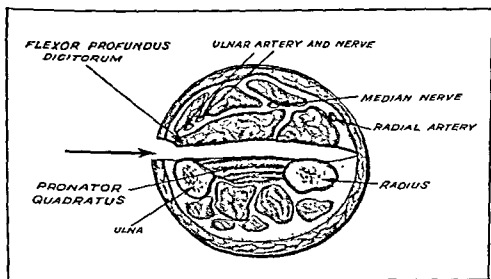


Fig. 1882.—CROSS-SECTION OF THE LOWER FOREARM TO SHOW THE PLANE IN WHICH PUS SPREADS FROM THE HAND TO THE FOREARM. DRAINAGE IS EFFECTED FROM THE ULNAR SIDE BETWEEN THE FLEXOR PROFUNDUS DIGITORUM AND THE PRONATOR QUADRATUS.

felt by the exploring finger. The distal end of the radial bursa is ruptured completely. The same procedure is adopted in the case of the ulnar bursa. A drainage-tube is unnecessary.

FASCIAL SPACE INFECTIONS

The Thenar Space

Boundaries of the Thenar Space

On the palmar aspect—the palmar fascia, which in this situation is thin and elastic.

On the dorsal surface—the adductor transversus pollicis.

On the ulnar side—a septum of strong fascia attached to the middle metacarpal bone. This septum separates the thenar from the middle palmar space (figs. 1883 and 1884).

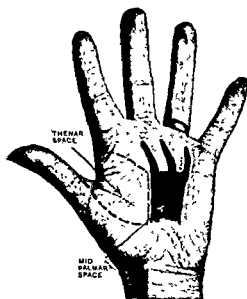


Fig. 1883.—THE RELATIVE POSITIONS OF THE THENAR AND MIDDLE PALMAR FASCIAL SPACES. NOTE THE THREE DIVERTICULA FROM THE MIDDLE PALMAR SPACE.

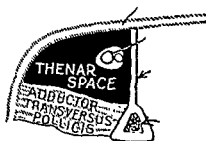


Fig. 1884.—DIAGRAM OF A TRANSVERSE SECTION THROUGH THE THENAR SPACE.

Source of infection. The thenar space may become infected directly from a wound. More frequently it is involved by the bursting of a pus-filled flexor tendon sheath of the index finger. Exceptionally it is infected in the same way from the flexor tendon sheath of the middle finger, and still more rarely from the flexor longus pollicis tendon sheath.



Fig. 1885.—"BALLOONING" OF THE THENAR EMINENCE: THE SIGN OF AN INFECTED THENAR FASCIAL SPACE.

Clinical features. Infections of the thenar fascial space produce much swelling. There is ballooning of the thenar eminence (fig. 1885). The thumb metacarpal becomes pushed away from the rest of the hand. Flexion of the distal phalanx may be considerable, but it lacks resistance to extension, which is so well defined in suppurative tenosynovitis of the flexor longus pollicis.

Treatment. Operation is imperative, the danger of delay is great. The results of opening a non-infected space are minimal.

The incision is made on the dorsum and is shown in figure 1886. The incision passes just to the radial side of the metacarpal of the index finger. A hæmostat is passed into the space and opened. This gives perfect drainage and no tube or other drainage material is necessary. It is, of course, essential to attend to a suppurative tenosynovitis if such is present.



Fig. 1886.—INCISION FOR DRAINING THE THENAR SPACE.

*Middle Palmar Space**Boundaries of the Middle Palmar Space*

On the dorsal aspect—fibrous tissue separating it from the interosseous muscles of the third and fourth spaces.

On the palmar aspect—fascia separating it from the flexor tendons of the middle, ring and little fingers with their lumbricals.

On the radial aspect—that fascial septum attached to the middle metacarpal which separates it from the thenar space (see figs. 1883 and 1884).

The middle palmar space has three diverticula, which are the lumbrical canals of the middle, ring and little fingers (see fig. 1880). It is overlapped on the ulnar side by the ulnar bursa; consequently, it must never be incised directly from the palm, otherwise the ulnar bursa will become infected, a very grave matter.

Sources of infection. The middle palmar space may become infected from rupture of the tendon sheath of the middle, ring or little fingers. It can also be infected directly by penetrating wounds of the palm, or from osteomyelitis of the middle or ring metacarpal bones. Very rarely, infection of this space occurs as an extension from the thenar space by a bursting of the septum which divides them.

Clinical features. Infections of the middle palmar space give rise to those enormous hands which may be likened to a whale's flapper. Obliteration of the concavity of the palm, and a slight bulging thereof, is almost pathognomonic of the condition. The convexity of the palm is never great because the resistance of the palmar fascia is so strong. Edema may obliterate concavity, but it never produces convexity. There is no point of maximal tenderness in middle palmar space infections.



Treatment. Direct attack being absolutely forbidden for reasons given above, efficient drainage of the middle palmar space may be secured via a lumbrical canal. This is effected by opening the web between the ring and middle fingers, or the ring and little fingers. If a choice exists, the former is chosen (fig. 1887). The fingers are spread. The incision begins on the dorsum, and passes over the web on to the palm, but never beyond the distal flexor crease. The incision is deepened. Pressure is exerted over the middle palmar space. If pus

wells up, a grooved director is inserted along the lumbrical canal. The incision is extended until the web is split completely almost to the distal flexor crease. A closed hæmostat is now inserted under the flexor tendon, and its jaws are opened widely. No drainage material is necessary.

An abscess of the middle palmar space is usually secondary to suppurative tenosynovitis of the middle or ring fingers, which of course will require appropriate attention.

Other Fascial Spaces

There are other fascial spaces in the hand, but they are of comparatively little importance. To describe them would be to confuse the

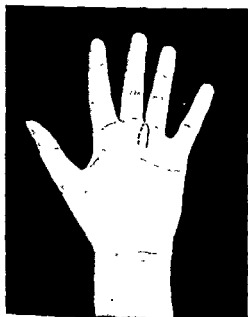


Fig. 1887.—INCISION FOR DRAINING THE MIDDLE PALMAR SPACE. ON NO ACCOUNT MUST THE SPACE BE DRAINED DIRECTLY THROUGH THE PALM.



Fig. 1888.—RADIOGRAPH SHOWING OSTEO-MYELITIS OF THE MIDDLE METACARPAL BONE. THIS PATIENT PRESENTED HIMSELF WITH AN INFECTED DORSAL SUBAPONEUROTIC SPACE.

issue. The only one of any real importance is a space on the back of the hand—the *dorsal subaponeurotic space*. When this is infected there is, as usual, swelling of the back of the hand, but there is also tender induration. Direct drainage can be carried out. In my experience, when this space is infected, the primary infection is often acute osteomyelitis of a metacarpal bone (fig. 1888).

AFTER-TREATMENT OF SERIOUS HAND INFECTION, WITH SPECIAL
REFERENCE TO SUPPURATIVE TENOSYNOVITIS

After the operation a malleable dorsal splint, bent at the wrist so as to hyperextend the hand, is applied. This prevents prolapse of tendons and mitigates dropped wrist. On the following day hot saline baths are commenced (fig. 1889). The baths are continued for two hours at a time, at three-hourly intervals. During the intervals gauze soaked in glycerol is applied. At night a large piece of Gamgee tissue soaked in a saturated solution of magnesium sulphate in hot water covers the whole palm and most of the forearm. Hyperextension is maintained by splinting. A suitable dose of morphia should be ordered for the first few nights. On the third or fourth day the hand must be



Fig. 1889.—ARM BATH FOR SERIOUS INFECTIONS OF THE HAND.

examined closely. If it looks sodden, the time and number of baths should be cut down. The sister in charge of the case is asked to put on gloves and to move the fingers gently in the bath. She is also requested not to squeeze the hand to try and express pus while dressing the wound. On the fifth to seventh days, according to circumstances, baths are stopped and also the fomentations at night. Dressings soaked in liquid paraffin are substituted. If the wounds are malodorous, instillations of H_2O_2 followed by irrigations with eusol are recommended.

SOME COMPLICATIONS NOT CONSIDERED ALREADY

In grave infections the treatment of actual or threatened septicaemia must, of course, receive prior consideration. Timely and suitable doses of anti-streptococcal serum should be given. In these grave cases we have considerable confidence in the continuous administration of saline

and glucose intravenously. To each pint of the intravenous fluid are added 4 cc. of a 1 per cent solution of mercurochrome.

One tendon sheath may be infected from another via a lumbrical canal. The surgeon should watch for this complication.

In suppurative tenosynovitis adequately opened, if the patient has much pain in the finger after the third day it is probable that osteomyelitis of the phalanges is proceeding.

In cases of prolonged suppuration where the pus is malodorous it is almost certain that one or more tendons are sloughing. Sloughing tendons should be excised (fig. 1890). Tendon necrosis occurs earliest beneath the anterior annular ligament, because here pressure is greatest. A tendon which is yellow and has lost its gloss is dead, and if such a condition is found at the primary operation or later, that tendon should be excised, but always with the following proviso: great care should be taken to catch in a hæmostat the proximal part of the tendon, and after the necessary portion has been excised, to stitch it to the periosteum or to the skin. If this is not done, the muscle will contract and carry infection into the palm or up the forearm, as the case may be.

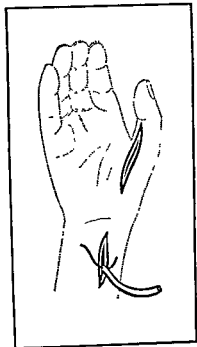


Fig. 1890.—EXCISION OF THE TENDON OF THE FLEXOR LONGUS POLLICIS. WHEN AN INFECTED TENDON IS EXCISED IT IS ESSENTIAL TO STITCH ITS PROXIMAL END TO THE WOUND.

ON THE ULTIMATE PROGNOSIS IN SUPPURATIVE TENOSYNOVITIS

Only when operative treatment is carried out within a few hours of infection, and even then only when the infection is comparatively mild, can complete restoration of digital function be expected. A stiff, soundly healed finger with movement at the metacarpophalangeal joint is about the best that can be expected. My own view is that in practically every walk of life a stiff finger is more of a handicap than the absence of a finger. When, in addition to suppurative tenosynovitis, osteomyelitis of a phalanx or phalanges has occurred, then indeed can there be no question as to the right course to adopt—amputation should be advised. The ideal time to perform amputation is after reasonable convalescence from the infection, when the infection is “dead” and when the wound has healed. Occasionally, disarticulation

of a finger must be undertaken during the active stage of the infection (see footnote, page 3316).

Providing amputation can be carried out *au froid*, an operation can be designed to leave the patient with the most useful and pleasing hand possible. In this connection I can heartily recommend total amputation—that is, the finger is amputated together with an appropriate portion of the corresponding metacarpal bone (fig. 1891). In the case of the index and little fingers Farabeuf's flap is used. It is absolute trash to say that the loss of the head of the metacarpal



Fig. 1891—SHOWING THE METHOD OF SECTIONING THE METACARPAL BONE IN TOTAL AMPUTATION OF A FINGER. IN THE CASE OF THE INDEX AND THE LITTLE FINGERS THE METACARPAL BONE IS SEVERED OBLIQUELY. IN THE MIDDLE AND RING FINGERS THE METACARPAL BONE IS DIVIDED STRAIGHT THROUGH THE SHAFT.

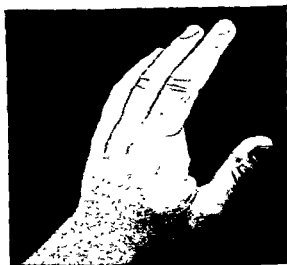


Fig. 1892—RESULT OF AMPUTATION OF THE INDEX FINGER WITH EXCISION OF THE HEAD OF THE METACARPAL. THE U SHAPED FLAP WAS USED.

weakens the hand. I have had this operation performed upon my own hand (fig. 1892), and I would not change this hand for one with a full complement of fingers; it is a strong fellow, and to me it is an advantage in operating. I have recommended and carried out total digital amputation scores of times and the patients are always delighted with the result. During the past ten years the only case of digital amputation *au froid* in which I have left the head of the metacarpal was in a professional boxer!

So much for the fingers. The case of a thumb is entirely different. Here, as always, the surgeon's watchword is "save all possible." Contrary to expectations the prognosis in suppurative tenosynovitis of the flexor longus pollicis (radial bursa) is not too bad. Even after the

loss of the flexor longus pollicis tendon (see fig. 1890), by virtue of the short flexors, a very useful thumb results.

From a functional point of view the worst prognosis occurs from those cases of total infection of both radial and ulnar bursæ—particularly the ulnar bursa—which have not been drained until a late hour, or have been drained imperfectly. In these unfortunates semi-claw hand is all that can be expected, but with months of persevering after-treatment even these patients eventually learn to make good use of their permanently maimed member. Such a hand is at least more useful than one clawed to the same extent from an irreparable nerve lesion.

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PART XVI
ORTHOPÆDICS

by
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ORTHOPÆDICS

CHAPTER I

DEFORMITIES OF THE FEET

FLAT FOOT

THE shape of the sole of the foot differs when the foot is supported with no weight resting on it from its shape when it is on the ground bearing the weight of the human body. In the latter case the shape is modified further by compression of the foot within the shoe. Normally, when the body is in the upright position, the skin covering the whole of the sole of the foot is not in contact with the ground. The heel, the outer border of the foot, and the forepart of the foot transmit body weight to the ground and so come in contact with it.

Anatomically, a number of arches in the foot can be described, but in the description of deformities of the foot, it is simpler to consider only the longitudinal arch on the inner side of the foot extending from the os calcis to the neck of the first metatarsal bone, and the transverse arch or metatarsal arch extending across the fore part of the foot at the level of the necks of the metatarsal bones. These arches are seen when the foot is in the resting position; when weight is borne on the foot, the longitudinal arch flattens out to some extent and the centre of the transverse arch drops, so that some consider that this arch does not exist at all in the upright posture.

The longitudinal arch consists of the bones on the inner side of the foot, which are of such a shape that when they are articulated they fit neatly together in a manner similar to the bricks over an archway. They are held together by ligaments of which the most important is the "spring" or calcaneo-scapoid ligament, which supports the neck of the astragalus on the inner side. The strength of the arch is added to by the arrangement of the muscles of the sole of the foot and by a number of muscles which extend from the leg to be inserted into the

foot, the most important of which is the tibialis posticus. When this arch is flattened, the neck of the astragalus and the scaphoid lose their support and are consequently nearer to the ground.

The transverse or metatarsal arch.

In the resting foot, the necks of the five metatarsal bones are arranged so that the second and third are at a higher (i.e. dorsal) level than the first, fourth and fifth; but when weight is borne on the foot, the convexity of the resting foot is decreased, though the second and third should not drop to a level below (i.e. on the plantar surface of) a line drawn between the middle of the neck of the first metatarsal to the middle of the neck of the fifth. The position of these bones is maintained by ligaments and small muscles of the foot. The breadth of the foot at the level of the heads of the metatarsals exceeds that at the base of the metatarsal bones. The big toe is normally the longest toe; the second is usually longer than the third; the second and third may be equal in length, and rarely the second is longer than the first.

An efficient muscular tone of the small muscles of the foot and the muscles of the leg is necessary for the maintenance of a normal foot.

TYPES OF FLAT FOOT

- (1) Acute flat foot.
- (2) Chronic flat foot.

(1) *Acute flat foot.*

This condition is best called *acute foot strain*, because in the majority of cases the arches are not in any way distorted during the first few weeks of the untreated condition. Almost invariably it is bilateral, and may affect feet which are normal or those with either a high or flat arch. It is seen most commonly in persons between the ages of fourteen and thirty. The sufferers may be healthy individuals or be slightly debilitated by an infection or over-tired. It is most common in the feet of patients who have been in bed subsequent to an operation or with influenza; it is seen in nurses during their first few weeks at work in the wards, and in poorly developed boys who on leaving school have started hard work wearing heavy boots. The symptom of this condition is a severe ache all over the feet generally all day long.

which is relieved soon after the boots or shoes are removed and the feet are put at rest, but returns as soon as the sufferer is on the feet again. A similar condition is produced as the result of any general infection, particularly rheumatic fever and a gonococcal infection of the joints and muscles of the feet.

Examination usually shows some swelling on the fore part of the foot on the dorsum, and tenderness of the muscles on the sole of the foot and under the scaphoid. Often the heel and the heads of the metatarsal bones are tender. "March fracture" must be excluded (see page 3344).

Treatment. The patient is put to bed for one week and is not allowed out of bed at all during this time except to have a hot bath each day. A purgative is given and any infection which is present is treated. Local treatment for the feet during this week is better avoided unless there is deformity of the foot, in which case the foot can be strapped up with elastoplast in the manner described below. At the end of the week the patient is allowed up but doing no work, and physical treatment is then commenced. This consists of faradic surging baths given daily. After a few treatments the patient starts inversion exercises, and if he has not been standing properly, he is taught how to stand with the feet inverted. At this time bedroom slippers and soft shoes should be avoided. Comfortable lace-up shoes should be worn, and the heels should be wedged on the inner side in the manner described below. Most patients, except those recovering from an illness, can start work in the third week, but should continue treatment for another two weeks.

A modification of this line of treatment is obviously necessary if the patient acquires the flat feet during the course of recovery from an illness, and if the foot strain occurs in one whose feet are considerably deformed before its onset.

Forcible manipulation of the feet affected by acute foot strain is harmful.

(2) *Chronic flat foot.*

A number of factors predispose to the origin of this condition. In children it is most common in those who are thin and poorly developed and in heavy children who walk late. In the first group, poor muscular tone is the chief cause, and in the heavy children the leg muscles and bones of the feet are called on to accomplish more than they can manage owing to the weight of the body, so that a deformity of the foot follows. In girls and boys, badly fitting shoes and rapid growth

may influence the onset of flat foot, particularly if the musculature of the body in general has not developed at the same rate as the skeleton, a factor probably common to a number of static deformities.

In adults flat foot and other deformities of the feet appear to occur without apparent reason apart from ill-fitting shoes, but are particularly common in middle-aged heavy women who stand a great deal. Injuries about the ankle and of the feet are liable to be followed by flat foot.

Symptoms. These vary a great deal, from an ache in the foot to pain in the calf. When the longitudinal arch is affected, pain is most common on the inner side of the foot under the neck of the astragalus and scaphoid, but is also seen up the inner side of the leg and up the outer side of the leg and thigh. In lesions of the metatarsal arch, the pain is situated in the region of the second and third metatarso-phalangeal joints. Pain of coincident deformities of the foot, such as hallux valgus, often overshadows any symptoms of flat foot. It is important to determine if the pain is due to a lesion of the transverse or longitudinal arch.

EXAMINATION OF A CASE OF SUPPOSED FLAT FOOT

(a) The patient is seated on a couch. The general shape of the foot is noted and the patient asked to indicate the site of the pain. The foot is palpated and examination particularly made for tender areas. These are found most frequently under the scaphoid, in the plantar fascia and under the middle of the transverse arch. The toes are examined, note being made of hallux valgus, hammer toes, overlapping toes, and the situation of corns. The colour of the toes and condition of the nails is noted, and in elderly patients the condition of the anterior and posterior tibial pulses. The sole of the foot is examined, particular notice being taken of the presence of any hard skin or corns under the middle of the transverse arch. The patient is told to dorsiflex the foot while the knees are straight, to test if the tendo Achillis is of normal length. The knees are examined for signs of arthritis.

(b) The patient is asked to stand up with the feet parallel to each other and five inches apart (in a child two inches). Standing in front of the feet it is possible to see if the patient is standing on the foot normally or bearing weight on the inner border of the foot. In the latter case the tubercle of the scaphoid and neck of the astragalus may

be prominent between the internal malleolus and the ground, and on the outer side of the foot more of the lateral surface of the heel is seen than should be. The patient is made to stand on the outer border of the foot and flex the toes; if he cannot do this, he is told to sit down again and the examiner attempts to put the foot into this position—one of full inversion of the foot and plantar flexion of the sole. When the patient is standing, deformity such as genu valgum and genu varum is noted, and in the case of a child the hip joint and spine should be examined.

Other examinations may be necessary, such as measuring the length of the limbs, examination of an old injured ankle, or other deformities of the limbs. In view of the fact that there may be manifestation of cardiac or renal disease shown by swelling of the feet, it may be necessary to examine these systems. Further, patients may seek advice about their feet which have been flat for many years, but symptoms have only arisen in them since the onset of other disease. This applies particularly to the onset of gangrene associated with diabetes, etc., and to diseases of the nervous system.

Diagnosis. It is convenient to classify cases of flat foot of the longitudinal arch into three degrees:

(1) The longitudinal arch is flat and the patient can correct the deformity when he is standing upright.

(2) The second degree is the condition when the patient cannot correct the deformity, but the examiner can do so with his hands.

(3) The third degree is a rigid flat foot which cannot be corrected by the patient or by the examiner.

Any of these three may be associated with hallux valgus or any deformity of the foot.

The metatarsal arch is seldom fixed in malposition except in cases of advanced multiple arthritis. It is considered to be dropped if there is an area of hard skin under the heads of the second and third metatarsal bones.

TREATMENT

Children. If the general health is not satisfactory this must be attended to while the treatment of the feet is commenced. Up to the age of five, children often have knock knees (and sometimes bow legs) in association with the first degree of flat foot.

(a) A child should wear light lace-up shoes with a heel, and this heel should be wedged $\frac{1}{8}$ inch on the inner side (fig. 1893). An advanced heel is not advocated, and the value of a wedged heel without a wedged sole is that the body weight is transferred on to the outer side of the foot. The longitudinal arch is raised more by wedging the heel alone than if the sole and heel are both wedged.



Fig. 1893.—CHILD'S SHOE WEDGED
ON INNER SIDE OF HEEL.

Massage is of value, particularly in the fat flabby children. In bad cases and in those not reacting to this treatment, leather valgus insoles are placed in the shoes (fig. 1894). After the age of five the above treatment is augmented by exercises.

(b) *Exercises* for flat foot should be carried out in an airy room. Three parallel lines should be drawn or painted on the floor; these should be one inch broad and separated from each other by three inches for a child and six inches for an adult. The lines should be the length of the room and extend up to one wall, on which is fixed a mirror at least a foot wide and four feet high. The patient should be clad lightly and should be wearing socks.

The object of the exercises is to strengthen the small muscles of the feet and the muscles of the legs that cause inversion of the feet. Sufficient variations should be taught to prevent the patient losing interest in them. Frequent rests should be given between the exercises. A trained masseur or masseuse should instruct the child in these exercises, and when he has learnt them, he should do them morning and evening when he is not tired, under the supervision of a parent or some competent person. The masseuse should then attend at intervals to see that they are being carried out correctly.



Fig. 1894.—LEATHER VALGUS INSOLE WITH A SPONGE METATARSAL BAR. THE SHOULDER AND INSOLE ARE ONE PIECE OF LEATHER, SORBO SPONGE IS USED FOR THE BAR AND THE WHOLE COVERED WITH THIN BAYL. THE METATARSAL BAR IS ONLY USED FOR ADULTS.

The typical exercises are :

- (1) Standing on the outer side of the feet with the toes flexed and sinking back to normal stance.
- (2) Standing in the position described in (1) and walking along the lines with the hands on the hips and body upright.
- (3) Tiptoe exercises with the toes turned in. Details of exercises can be obtained from books on physio-therapy.

The masseuse may assist by stretching the tendo Achillis and by manipulation of the knees and feet.



Fig. 1805.—STANCE WITH FEET INVERTED.

(c) It is most important that the child should be taught the *habit of standing* correctly. This not only helps to cure the flat foot but is a relief in cases of pain under the longitudinal arch. When children have to stand for any length of time they should be encouraged to acquire the habit of standing with one foot fully inverted and the other one in *normal position*, and after a minute changing over and placing the other foot in the inverted position.

A few children under the age of five, and a number after that age, are first seen when there is an advanced degree of flat foot that is unlikely to respond to treatment by exercises and shoes alone. This type of case and one which has not improved with physical treatment is treated by putting the feet in the position of full inversion (over-correction) and fixing them there in plaster of Paris from the toes up

to the knee, for a month. Sometimes an anæsthetic is necessary for this operation. At the end of that time exercises are commenced and appropriate shoes are worn. In a few cases an outside iron and inside T-strap are required.

Adults. It is usually inadvisable to order treatment for mild or moderate cases of flat foot giving rise to no symptoms. The following treatment is suitable for patients not suffering from associated conditions such as hallux valgus and hammer toes, but may be employed when the latter have been corrected.

General principles of treatment are that when a patient is of such an age that the arches can be restored, every attempt should be made to do so, but, if it is unlikely that this can be accomplished, relief from symptoms is aimed at by the treatment.

The *treatment of first degree flat foot*, i.e. mobile foot when the patient can correct the deformity, is as follows :

(a) *Lace-up shoes* should be worn with the inner side of the heel wedged $\frac{3}{8}$ inch. The inner border of the sole should be nearly straight and the instep should be firm. A woman's shoes should have a cuban heel, which should be of a height most comfortable to her and not exceeding $1\frac{1}{2}$ inches. Long hours in bedroom slippers and other shoes providing no support are harmful.

(b) *Physical treatment* consists of faradic surging baths, and exercises should be given. The faradic surging baths are intended to strengthen the small muscles of the foot over which the patient has little voluntary control. One treatment a day should be given, and at least twelve treatments in all, arranged so that there are four or five the first week, three the second week, and two subsequently. The patient should rest with the feet up for half an hour after each treatment.

Inversion exercises should be taught on the lines indicated above. They should be carried out by preference at a different time of day from the faradic baths.

(c) The habit of standing with one foot at a time inverted should be encouraged.

Second degree of flat foot is treated by loosening up the foot under anæsthesia. Relaxation is obtained under evipan or gas and oxygen. An attempt is made to loosen every joint of the foot, particularly the sub-astragaloid and metatarsal joints. At the completion of the manipulation it should be possible fully to invert the heel and to make

a supple longitudinal and transverse arch. Great strength is not required for this manipulation, but a careful plan of campaign so that each joint is mobilised in turn. Before the patient recovers from the anæsthetic, a piece of elastoplast is placed round the fore part of the foot to hold the transverse arch in the over-corrected position, and another piece round the mid-tarsal joint which passes above the ankle joint. The patient is told to keep off the foot for twenty-four hours, and then to have the elastoplast removed and to start the treatment recommended for first degree flat foot. The footwear previously worn should be discarded, and it is essential that the correct footgear should be used straight away.

Treatment of third degree flat foot, when all the joints are fixed in malposition, is straightforward in patients in the first half of life, but

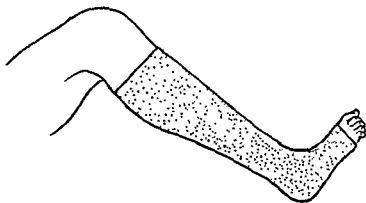


FIG. 1896.—PLASTER OF PARIS APPLIED TO THE LEG AND FOOT. THE FOOT IS IN AN OVER-CORRECTED POSITION AND AT RIGHT ANGLES TO THE LEG.

in the latter half each case must be considered separately. Provided that there are no signs of acute inflammation in the joints of the foot, patients in the first half of life are given a general anæsthetic and the joints of the feet are mobilised; the feet and legs are put into plaster of Paris extending from the necks of the metatarsal bones to the top of the calf. The foot is put into an over-corrected position and at right angles with the leg; the heel is fully inverted and as high an arch as possible is made, the fore part of the foot being put square. This plaster is left on for three weeks. When it is removed the foot is usually found to be supple, and the treatment for first degree flat foot is then commenced. The feet are usually tender when the plaster is removed. A leather valgus insole should be worn in addition to the wedged heel. The patient should not be on his feet more than necessary for two weeks after the plaster is removed.

During the latter half of life this line of treatment is suitable for

correctly fitting elastic or crêpe elastic garter should be worn at night. When there is limited flexure of the metatarso-phalangeal joints, these should be loosened under gas anæsthesia. Faradic surging baths and flexion exercises of the toes are often very helpful. A metatarsal bar on the outside of the shoe is more clumsy and less comfortable than an insole.

If other deformities of the feet are present it is usually advisable to correct them at the same time.

Two further conditions which produce pain in the metatarsal region must be considered—"march fracture" and "osteochondritis" of the metatarsal heads.

March fracture means a fracture of a metatarsal bone, usually the second and less often the third, which occurs in a young adult who is often debilitated and on the feet for a long time. The name is derived from its occurrence in soldiers. It is also seen in nurses and others who work long hours. There is no history of trauma and the signs and symptoms are a painful foot with swelling and tenderness over the affected bone. The skiagram shows a crack in the narrow part of the shaft, usually with no displacement. If the patient has walked on the foot for some time after the onset of symptoms, ossified callus, making a spindle-shaped swelling on the metatarsal shaft, may be seen.

The condition is treated by immobilisation of the foot in plaster of Paris for five or six weeks until the bone is firmly united and the foot painless. A sorbo sponge insole should be worn and the feet relieved of arduous standing until the patient's general health is satisfactory.

Osteochondritis may affect the articular surface and underlying bone of one or more metatarsal heads, before the epiphysis has joined the shaft. The ætiology of the condition is undoubtedly similar to that of pseudo-coxalgia of the upper femoral epiphysis, and although it is not proven, there is considerable evidence to show that alteration of the blood supply is the cause of the change and that this may be brought about by trauma.

The articular cartilage becomes softened and the ossified portion of the epiphysis fragmented and flattened, so that when the epiphysis has joined the shaft, the head of the bone is deformed. The second metatarsal is most commonly affected. The patient's complaint is pain and swelling, and this may be more serious some time after than at the time of the injury owing to recurrent effusion into the metatarso-phalangeal joint or to arthritis. Treatment is directed to keeping the

weight off the affected area by shoes or an insole. Persistence of the symptoms may necessitate removal of the head of the metatarsal bone.

SPASTIC FLAT FOOT (PERONEAL SPASM)

This condition is relatively uncommon and is usually seen in boys and young adults. It is quite distinct from the rigid flat foot, and is due to a spasm of the everters of the foot. The peronei are seen to stand out in spasm often when the patient is recumbent, and particularly when he stands and attempts to invert the foot. It may be unilateral or bilateral and sometimes the patient is debilitated, a septic focus being present elsewhere in the body. Arthritis develops in the joints on the inner border of the foot, particularly in the astragalo-scaphoid joint when the condition has been present for a comparatively short time—possibly it is the precursor of the spasm in the peronei.

The treatment is difficult, and it is impossible to give a prognosis with regard to the condition during the early stages of treatment. The general condition of the patient should be improved. There are three alternative methods of treatment :

(1) Under general anæsthetic, the feet are manipulated, followed by the application of plaster of Paris from the toes to the knee with the foot in the over-correct position. At the end of three weeks this is removed and the foot is re-examined. If the spasm has disappeared, the treatment for first degree flat foot, described above, is carried out. If there is no spasm when the patient is examined in another two weeks, there is every probability that this line of treatment will be successful. Unfortunately it is found in a number of cases that the spasm is still present when the plaster of Paris is removed, while others have a recurrence of the spasm subsequent to this line of treatment. However, it is considered that this should be tried before resorting to any operation.

Failure of this necessitates either :

(2) Division of the peronei, or

(3) Arthrodesis of the astragalo-scaphoid joint and division of the peronei. If the peronei alone are divided, this should be done above the external malleolus by an open operation and the tendons re-sutured after lengthening them. If the arthrodesis is carried out, the peronei can either be lengthened by this method or tenotomised. There is no

doubt that division of the peronei muscles alone is not always a cure for the condition, so that arthrodesis plus peroneal division is advocated in all cases of spastic flat feet which have not been cured by manipulation and plaster. After the arthrodesis, the leg and foot are put in plaster for eight weeks. Subsequent to this operation, the patient is given corrected shoes with the heels wedged on the inner side. Physical treatment is not usually required.

AFFECTIONS OF THE TOES

Big Toe. Injury to the big toe occurs from stubbing by wearing thin or ill-fitting shoes, particularly on hard ground, and by direct violence. Injury to the interphalangeal joint may produce an effusion into that joint so that there is swelling and pain on flexion and extension. The dorsal covering to the joint is the spread out tendon of the extensor longus hallucis, and an inflammatory condition is shown by crepitation under the extensor tendon when the terminal phalanx is moved; this condition is treated by fixing the joint with elastoplast for three weeks.

Acute hallux rigidus. Tenosynovitis of the extensor longus hallucis may be localised for a distance of one to two inches over the first metatarso-phalangeal joint or may extend for the whole length of the tendon sheath. The patient complains of pain on the dorsum of the foot when walking and when the big toe is moved, and there is swelling. Examination shows a swelling in the course of the tendon, which is fluctuant if fluid is present, and crepitant if the inflammatory reaction produces a sticky surface between tendon and tendon sheath. Pain is produced in the course of the extensor tendon when this is alternately put in action and relaxed. It is not infrequent to find that the most tender place is where the edge of the upper of the shoe crosses the tendon or over the metatarso-phalangeal joint.

Treatment. Rest is required. The ideal is that the patient should be put to bed with the foot fixed at right angles to the leg and the big toe immobilised. This can be done by a plaster shoe or by a back splint and a foot piece, to which the foot and big toe are fixed with strapping for ten days. Subsequently the big toe and foot are strapped up. However, frequently the patient wishes to avoid rest in bed so that it is necessary to treat the case otherwise. Dancing and games should be forbidden, elastoplast should be bound round the big toe, foot and

ankle so as to hold the big toe as rigid as possible and to make pressure over the swollen tendon sheath. This is changed in ten days and reapplied for an equal period. This lesion is often neglected by the patient, and when first seen for treatment there may have been two or three exacerbations so that three weeks' treatment may not be sufficient to cure the condition.

Acute traumatic arthritis of the big toe joint (first metatarso-phalangeal joint) occurs in young adults, producing pain under the big toe on walking and inability to move the big toe. Examination shows swelling and partial or complete fixation of the joint. There is pain when the phalanx is moved on the metatarsal head, and the extensor tendon may be held in spasm. The differential diagnosis is from tenosynovitis described above, and from osteo-arthritis which is described subsequently.

The treatment is often made difficult by the patient continuing to walk about for some time after the onset of the condition and by refusal to rest in bed. The ideal is that the patient should go to bed and have pressure applied to the joint by strapping. Radiant heat can be applied through the strapping. Ten days' rest is likely to cure the condition, and recurrence should be prevented by fitting comfortable shoes and limiting the weight taken by the joint by one of three methods :

- (i) Specially made shoes in which the ball of the big toe is sunken and the sole of the shoe is built well up behind this hollow.
- (ii) An insole with a sponge bar.
- (iii) A metatarsal bar of leather placed behind the metatarsal head on or in the sole of the boot.

Chronic affections. When the big toe joint is affected with osteo-arthritis, sooner or later either the condition of hallux rigidus or hallux valgus is produced. The changes of osteo-arthritis in this joint are similar to those of other joints, but lipping of the internal and superior aspect of the head of the metatarsal bone is a prominent feature.

Chronic hallux rigidus means a stiff big toe. Normally some degree of plantar flexion is possible at the big toe joint and about ninety degrees of dorsiflexion. Hallux rigidus may be developed to such an extent that the toe joint is completely fixed. It may be fixed quite

straight or slightly cocked up. In the earlier stages the condition is painful, but when the joint is ankylosed the patient is often free from pain. There is often a soft swelling overlying a hard ridge which consists of a new formation of bone and cartilage on the superior surface of the head of the first metatarsal bone. X-ray examination shows diminution of the joint space and the formation of the new bone on the head of the first metatarsal.

Treatment. If the patient is elderly or refuses operative treatment, some relief is obtained by well-fitting shoes built so as to avoid weight being taken on the ball of the big toe. However, by means of operative treatment a movable joint can be obtained. In young patients and those who have no perceptible changes in the joint surfaces apart from the lipping (new formation of cartilage and bone on the superior surface of the head of the first metatarsal bone), this lipping is removed with a chisel so as to make the superior surface of the metatarsal head flush with the shaft. This operation is most suitable in young patients who have an overgrowth of cartilage but no formation of bone. It is tempting to advise this small operative measure instead of the more radical one of excision of the head, but the smaller one is not always followed by as freely movable a joint and as painless a one as would be expected at the time of operation. It frequently appears that a practically normal joint is left when this lipping is removed, and although further lipping does not occur, a number of patients have not as comfortable a big toe or one as mobile after excision of the lipping, even when they are wearing specially made shoes. Consequently the tendency is to advise the more radical operation of excision of the head of the metatarsal bone in hallux rigidus due to osteo-arthritis, except in patients under about the age of thirty-five. Details of the operation of excision of the head are described under Hallux Valgus.

Hallux valgus means a deviation outwards of the big toe at the first metatarso-phalangeal joint. It is far more common in women than in men, and occurs most commonly in those who have worn ill-fitting shoes for many years. The error in the shoes in most cases is the shape of the inner border of the shoe, the fore part of which presses the big toe outwards and is usually associated with compression of the toes. A number of people are born with an *abnormal first metatarsal* bone which does not lie parallel to the others, but is deviated inwards; consequently, there is a gap between the first and second metatarsal

heads and the big toe is easily diverted into a valgus position. Other cases of hallux valgus are almost invariably associated with flat foot. The symptoms produced may be due to corns, recurrent arthritis in the joint, or bursitis.

Examination shows a variety of conditions, the deformity of the toe being obvious, while the end of the toe may be under or above the second toe, which is frequently a hammer toe. The end of the big toe and toe-nail may be deformed. On the inner side of the big toe joint a corn overlies a bursa which may contain fluid or jelly and is liable to recurrent attacks of suppuration. The extent of movement may vary from 60 per cent of normal movement to fixation. Associated deformities of the transverse and longitudinal arch are usually present. X-ray examination shows the extent of arthritis of the joint and the lipping.

Treatment. If operation is contra-indicated by age, disease, extensive varices of the legs or other conditions, the patient is made as comfortable as possible by specially made shoes or by the wearing of metal sole plates in shoes which are made of good glacé kid or suede. Recurrent pain, recurrent suppuration in the bursa, and difficulty in walking in the otherwise healthy adult are indications for operation, if relief is not obtained by well-fitting shoes.

Many operations have been devised for this condition; two are probably more beneficial than the others.

(1) The "slicing" operation.

(2) Excision of the head of the first metatarsal bone.

Excision of the bursa alone is a palliative measure that is of no value, as the underlying lipping remains, and the bursa may re-form.

Aspiration of the bursa will serve a similar purpose only. Suppuration in the bursa may require incision, or may settle down with the application of iodine or fomentations, if the part is rested.

No operation should be carried out on the joint within six weeks of suppuration in the overlying bursa.

A slicing operation is chosen by preference for young patients when arthritis of the joint is negligible except on the inner side. It is employed at any age when there is considerable prominence on the inner side of the head of the first metatarsal bone, but little arthritis is seen in the rest of the joint on the operating table. It should never be employed when there are spurs of bone on the inner and anterior edges of the head of the metatarsal bone, when there are spurs of bone on the outer side of the head of the metatarsal bone, and when there

is considerable osteo-arthritis of the joint. If there is doubt as to whether this operation or excision of the head should be employed, excision of the head is advocated.

(1) *Slicing operation.* A tourniquet is applied, and a curved incision is made, $2\frac{1}{2}$ inches in length, extending from the lateral surface of the base of the first phalanx over the middle of the head of the first metatarsal bone and outwards on the proximal side of the bunion, so that the convexity of the incision is on the dorsum of the foot. This flap is dissected back; it is usually necessary to ligate a prominent vein, but a digital nerve should be pushed inwards with the flap. If the bursa is opened, one wall of it is removed. An incision is made in

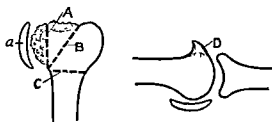


Fig. 1900A.—PART OF THE FIRST METATARSAL BONE AFFECTED WITH OSTEO-ARTHRITIS.

- A. Line of section for slicing operation.
- B. Line of section for removal of half the head.
- C. Line of section for removal of the head.
- a Bursa.

Fig. 1900B.—BIG TOE JOINT SHOWING SPUR ON ANTERIOR SURFACE OF HEAD.

- D. Line of section for removal of spur.

the line of the metatarsal bone just in front of the prominence caused by the lipping. This is carried right down to the periosteum on the shaft and forward through the capsule of the joint. The internal lateral ligament is dissected up from the metatarsal bone so that it is left fixed to the base of the phalanx but is otherwise free. The anterior part of the capsule of the joint is opened further so that about half of the head is exposed. A chisel is now applied and a slice of bone cut off from the inner side of the shaft of the metatarsal bone and the head, including the new bone formation on the inner side of the head. The quantity of bone removed from the head of the metatarsal bone varies with different operators, but probably the best results are obtained from this operation by the removal of at least one-third of the head. The piece of bone chiselled off is freed from any attachment posteriorly and removed. With a tenotomy knife the external lateral ligament and any tight capsular bands are divided; the internal lateral ligament is

now fixed back to the metatarsal bone by stitching it to the edges of the periosteum which have been raised from the side of the metatarsal bone. One stitch is generally necessary in the anterior part of the capsule; the skin is sutured and, after a dressing has been applied, the big toe is fixed with a bandage and elastoplast in a position of slight plantar flexion and adduction, i.e. drawn downwards and inwards from the other toes.

The stitches are removed in ten days and the toe fixed again in this position. Encouragement is given to the patient to move the other toes and the rest of the foot, but he should not walk for three weeks.

It may be necessary to have faradic surging baths to tone up the muscles of the foot. It is important that shoes after the operation should have support behind the ball of the big toe and have a straight inner border.

(2) *Excision of the head of the first metatarsal bone.* A tourniquet is applied and a curved incision is made, $2\frac{1}{2}$ inches long, extending from the lateral surface of the base of the first phalanx over the middle of the head of the first metatarsal bone and downwards on the proximal side of the bunion so that the convexity of the incision is on the dorsum of the foot. This flap is dissected back, when it is usually necessary to ligate a prominent vein, but a digital nerve should be pushed inwards with a flap. A flap is now dissected up from the inner and anterior surface of the joint; if the bursa is opened in dissecting up this flap, one wall of it is cut away. This flap has its base mostly on the inner side of the neck of the metatarsal bone, and also includes the capsule on the front of the bone. When this has been dissected up, the front of the joint can be seen. The soft tissues, including the external lateral ligament, are divided from the side of the metatarsal neck with a knife and periosteal elevator; a transverse incision is made across the shaft of the metatarsal bone, $\frac{1}{2}$ – $\frac{3}{4}$ inch from the joint, and the fan-shaped periosteal elevator pushes back the periosteum for $\frac{1}{2}$ inch from the anterior and lateral surfaces of the neck of the bone. A sand-bag is now pushed firmly against the sole of the foot and a thin-bladed chisel applied to the metatarsal neck in the line, $\frac{1}{2}$ inch wide, which has been cleared of periosteum. The bone is cut through, taking care that the chisel is at right angles to the bone or has a slight inclination forwards, so that the line of section leaves slightly more bone on the sole of the foot than on the dorsum. When the section is complete, the head of the bone is grasped with toothed bone forceps and removed after separating any soft tissues which may have remained attached.

The assistant grasps the big toe so as to enlarge the space between the base of the phalanx and the cut surface, and the area is dried. If there are any spikes of bone, these are removed with small bone-cutting forceps, a file is applied to the end of the bone and the edges are rounded. It is most important that no sharp edges of bone should be left. The flap is sutured back in place with no tension (if it is sutured back too tightly, cocking up of the big toe is liable to occur); the skin is sutured and the big toe bandaged into flexion and adduction as in the previous operation.

Stitches are removed in ten days. The patient is then measured for shoes or insoles. If shoes are built, they should be of such a type as is described to be worn after the slicing operation. If an insole is supplied, this has a sponge metatarsal bar and should be worn in the shoes with a straight inner border. The toe is fixed back into the over-corrected position and a band of elastoplast is applied round the foot behind the necks of the metatarsal bones so as to hold up the transverse arch as much as possible. The patient is encouraged to move the other toes and the remainder of the foot. He is allowed to hobble on the heels in three weeks, but should not walk for a month after the operation, and then only in the correct footwear. Faradic surging baths may be necessary to strengthen the muscles of the foot.

It takes some time for these patients to get comfortable after the operation, and all are more satisfied with the result twelve months after it than they are at six months.

Second Toe. This is the toe most commonly affected with the deformity called *hammer toe*. The other toes may be similarly affected. In the typical condition of hammer toe the first phalanx is cocked up and the second phalanx flexed. There is a corn overlying a bursa over the first interphalangeal joint and this is liable to suppuration. There is usually hard skin and often a corn at the end of the toe. The condition is frequently combined with hallux valgus, in which case the big toe may rest on the nail of the second toe.

Slight degrees of hammer toe, particularly in children, may be treated by splints worn at night. Mild degrees may be treated by tenotomy of tendons (often the extensor is cut as well as the flexor) and the capsule on the plantar surface of the first interphalangeal joint is divided; the toe is then splinted. There is a tendency for this to be followed by a recurrence, but it is often undertaken when a large number of toes are cocked up and the surgeon wishes to limit the number of operations on the small bones.



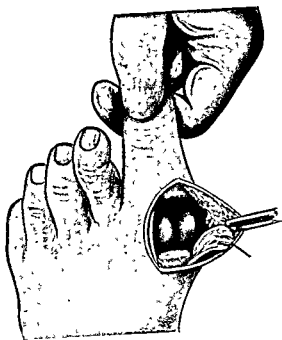
A.



B.



C.



D.

Fig. 1901.—DIAGRAMS OF OPERATION FOR HALLUX VALGUS. A. SKIN INCISION. B. INCISION IN CAPSULE. C. FLAP OF CAPSULE RETRACTED, LINE OF SECTION OF METATARSAL BONE. D. SHOWS GAP AFTER REMOVAL OF THE HEAD. TWO SESAMOID BONES CAN BE SEEN IN THE FLOOR OF THE WOUND.

The operation of choice for hammer toe is one which produces straightening of the toe and bony ankylosis of the first interphalangeal joint. The operation advised is as follows :

A tourniquet is applied, and a piece of gauze is put round the three outer toes to draw them outwards, and another round the big toe to draw it inwards. An elliptical incision is made around the corn, and this area of skin with corn and bursa is removed, laying bare the extensor tendon where it forms the capsule of the joint. The extensor

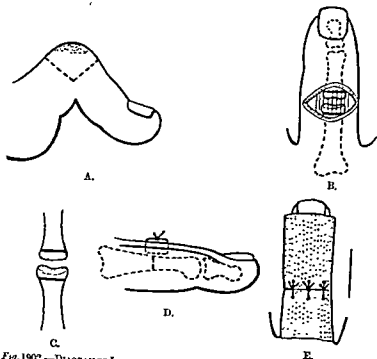


Fig. 1902.—DIAGRAM TO INDICATE OPERATION FOR HAMMER TOE. A. SKIN INCISION. B. THE CORN AND SKIN HAVE BEEN REMOVED, THE EXTENSOR TENDON IS EXPOSED. C. LINE OF SECTION OF BONE. D. THE OPERATION IS COMPLETED. THE FIRST AND SECOND PHALANGES ARE LYING STRAIGHT AND IN APPPOSITION. THE SKIN STITCH PASSES THROUGH THE EXTENSOR TENDON AND SKIN. E. GAUZE COLLODION SPLIT, THE THREE STITCHES AND SCAR ARE INDICATED BUT ARE CONCEALED BY THE GAUZE.

tendon is cut across over the base of the phalanx and dissected up off the head of the first phalanx and from the base of the second. A small chisel is used to remove the head of the first phalanx and the base of the second. The two surfaces of bone are then opposed, and if the toe will not lie straight comfortably, the flexor tendon is divided with a tenotomy knife. The toe is held straight. Fine silkworm-gut is used on a half circle needle for three stitches ; the central one passes over the middle of the incision through the skin on the distal side, the two cut surfaces of the extensor tendon, which are trimmed to correct length,

and out through the skin on the proximal side. This is tied and a stitch put in on each side. The toe should then lie straight and in the correct position. A piece of gauze is folded so that it is as wide as the length of the toe and soaked in collodion; this is bound round the toe tightly and when the collodion has set, it acts as a firm splint for the toe and no further dressing is required. It is cut off in ten days with a pair of scissors, the stitches removed, and a similar piece applied for another two weeks, when bony union is usually present. If the toe is not comfortable at the end of that time, a further splint of collodion or elastoplast should be applied.

Cocked-up Little Toe. This condition often gives considerable inconvenience, largely owing to a corn which is liable to develop over it. Its removal at the metatarso-phalangeal joint is advocated in large feet when the little toe is short. In other feet its removal is liable to be followed by trouble with the fourth toe, which may cock up in a similar manner and acquire a corn; consequently every effort should be made to avoid operation by providing soft broad-toed shoes. Treatment of the corn by salicylic acid and lamb's wool will be beneficial.

Curled-under Toes. These are common in children and adults. An attempt may be made in children to straighten them by frequent manipulation, by the wearing of tape or chamois bound round the toes to straighten them at night, and by the provision of broad shoes. Later in life symptoms produced by them should be relieved by great care of the foot, careful drying of the toes, the use of foot powder, care of corns, and well-fitting shoes.

AFFECTIONS OF THE HEELS

Short Tendo Achillis. In the normal limb the foot can be dorsiflexed above a right angle to a greater extent in children than in adults. A number of patients with flat foot, particularly women and girls, have a short tendo Achillis, so that the foot can only be dorsiflexed to a right angle or even less. The condition should be treated by stretching of the gastrocnemius by a masseuse and by exercises. The heel of the shoe should be raised one or two layers of leather until the patient is comfortable with an ordinary heel. It is seldom necessary to divide the tendon and elongate it in such cases. Reference is made to short tendo Achillis in association with claw foot under "*Pes Cavus*." When the tendo Achillis is short owing to over-action of the gastrocnemii due

to paralysis of the anterior tibial group of muscles in infantile paralysis, etc., the condition will necessitate different treatment, as other factors have to be considered.

Enlargement of the tuberosity of the os calcis. Tender areas are frequently seen on the outer or inner side of the heel. The skin may be reddened and a bursa palpable beneath it. This may overlie an enlargement of the tuberosity of the os calcis. It probably arises from a rub from the back of the shoe in tightly fitting shoes or riding boots. Friction causes periodic exacerbations of the symptoms. The non-operative treatment is directed to avoid the area being rubbed; iodex can be rubbed in as a counter-irritant. A larger pair of shoes is worn and the heels lined with sorbo sponge. Operative treatment consists in the removal of the bursa and of the prominent underlying bone with a chisel so that the surface of the os calcis is quite flat.

Spur on the os calcis. Injury to the long plantar ligament may cause it to be torn from its attachment to the os calcis. In the healing process, ossification may occur at the attachment of the ligament; this is particularly likely to occur in heavy men. Others who develop spurs are usually patients with multiple arthritis, who are liable to attacks of fibrositis in various parts of the body. The symptom of this condition is pain in the heels on standing and walking. A tender area the size of a shilling is usually found under the tuberosity of the os calcis on the inner side. An X-ray photograph reveals the presence of a spur usually $\frac{1}{2}$ inch broad at its attachment to the os calcis and extending forwards to a point. If there are no changes in the X-ray, there is an inflammatory condition of the periosteum of the os calcis or in the long plantar ligament. For a spur non-operative treatment should always be tried. This consists in the provision of a leather insole to fit the whole of the shoe; the heel of the leather insole is covered with sorbo sponge $\frac{1}{2}$ inch thick, the centre of which is cut away so that there is a hollow the size of a half-crown in the middle of the heel. This is an attempt to keep the patient's weight off the spur. Should this not supply the necessary relief, the spur can be removed.

PES CAVUS OR CLAW FOOT

This condition may be congenital or acquired. It is usually acquired, and arises secondary to disease of the nervous system such as infantile paralysis and Friedreich's ataxy. Cases secondary to infantile paralysis

are most commonly brought for treatment as children, but most of the other cases do not seek treatment until the second decade.

The characteristic shape of the foot is a high arch, prominent ball of the big toe and cocked-up toes. In a severe case when the patient stands, he stands on the fore part of the foot and sometimes cannot bring the heel to the ground. The latter is seldom due to shortening of the tendo Achillis, but usually to the secondary changes in the shape of the joints of the foot. The condition is not painful until corns and hard skin appear.

Treatment. Before considering the treatment, every effort should be made to find out the cause of the claw foot, and it is often advisable to consult with a neurologist regarding the ætiology. This is emphasised because the patient will gain no advantage by correction of foot deformity if the disease of the nervous system is advancing rapidly; in fact, the condition will recur, particularly when it arises in association with disseminated sclerosis; on the other hand, the majority of patients with Friedreich's ataxy are benefited by correction of the foot.

Any operation performed is planned so as to produce a normal shaped foot which will not revert to its previous deformity. The type of operation depends on the age of the patient and the extent of the deformity. Slight cases are treated by lowering the heel of the normal shoe. The majority of cases fall into three groups in the consideration of treatment.

Group 1. Examination shows that there is a high arch and tight plantar fascia, and the toes are not cocked up to any extent. Most of the cases falling into this group are children who have had infantile paralysis. The treatment consists in:

- (a) Steindler's operation.
- (b) Putting the leg and foot in plaster of Paris for three weeks.
- (c) The provision of shoes with a low heel.

Steindler's operation. A tourniquet is applied round the thigh, the outer side of the foot being placed on a sand-bag. An incision $2\frac{1}{2}$ inches long is made on the inner side of the heel, $\frac{1}{2}$ – $\frac{3}{4}$ inch above the sole. The incision extends down to the os calcis.

(i) The sole of the foot is put on the stretch and a small scalpel passed through the incision parallel to the sole of the foot close to the front of the tuberosity of the os calcis. The blade is turned, so that it

faces the sole, and all the tight bands of the plantar aponeurosis and calcaneo-metatarsal bands are cut close to their origin.

(ii) Without removing the knife from the wound, the blade is reversed so as to cut down firmly on to the under-surface of the os calcis. A fan-shaped periosteal elevator is put into the wound and all



Fig. 1903.—PES CAVUS OPERATION. LINE OF INCISION FOR STEINDLER'S OPERATION.

the structures attached to the lower surface of the os calcis, including the long plantar ligament, are pushed forward in the direction of the cuboid.

(iii) The knife is put into the wound again and an oblique incision made on the inner surface of the os calcis behind the long tendons and vessels. A periosteal elevator is inserted and the structures pushed forward from this side of the bone. The foot should now be of normal shape. The wound is closed with three silkworm-gut sutures, and dressing and plaster are applied.

Group 2. These cases require a more elaborate operative procedure in that correction of the longitudinal arch only is insufficient. Patients who have a very broad fore part of the foot and hard skin in the centre under the transverse arch, but no obvious bony deformity, fall into this group. The treatment consists in :

(a) Steindler's operation.

(b) Plaster for three weeks, followed by

(c) Tendon transplantation and division of the anterior part of the capsule of the metatarso-phalangeal joints.

(d) Plaster for three months.

Operation of tendon transplantation. This operation consists in the transplantation of tendons of the extensor longus digitorum to the necks of the metatarsal bones. Greatest advantage is obtained by transplanting the tendons of the second and third toes so as to hold up the middle of the transverse arch. It is essential that the capsules of the joints should be divided in front at the same time. The operation is performed through incisions overlying the distal half of the metatarsal bone and metatarso-phalangeal joint. The extensor tendon is divided and passed through a hole drilled in the neck of the metatarsal bone; it is turned back and stitched to itself.

The operation is not easy, but is followed by gratifying results.

Group 3. These cases require bone section; there is not only a high arch but also fixed bony deformity on the dorsum of the foot on the outer side. The treatment consists in:

(a) Steindler's operation, which is done at some time or preferably three weeks prior to

(b) A wedge osteotomy.

(c) Plaster for three months.

The wedge osteotomy is carried out through an incision on the outer side of the foot. The amount of bone to be removed is best judged by taking measurements on the X-ray photographs taken prior to the operation. The base of the wedge is above and to the outer side. Bone removed consists of portions of the astragalus or calcis, scaphoid and cuboid.

The full details of the operation for pes cavus have not been described, but sufficient to enable the operation to be planned. Patients who have had tendon transplantation usually have more comfortable feet than those who have had a bone section.

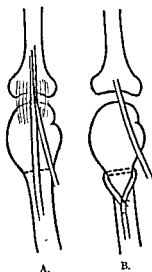


Fig. 1904.—TENDON TRANSPLANTATION.

A. SHOWS LONG EXTENSOR TENDON AND SECOND METATARSO-PHALANGEAL JOINT

B. SHOWS LONG EXTENSOR TENDON HAS BEEN PASSED THROUGH THE NECK OF THE METATARSAL BONE, BROUGHT BACK AND SUTURED TO ITSELF.

It is important to avoid tenotomy of the tendo Achillis in cases of pes cavus. This procedure should be reserved for the rare cases in which there is an associated shortening of this tendon, and then it should be adopted after the true cavus has been corrected.

CHAPTER II

DISABILITIES OF THE KNEE JOINT

It is essential to know in detail the anatomy of the knee joint in order to :

- (a) Understand how the injuries occur.
- (b) Make a correct diagnosis.
- (c) Direct non-operative treatment (physical).
- (d) Carry out operative treatment when necessary.

The anatomy of the synovial membrane and crucial ligaments is as important as that of the lateral ligaments and semilunar cartilages. This is described in detail in the larger text-books of anatomy and orthopædic surgery so that, in this chapter, reference is only made to particular anatomical points in connection with each injury.

Extension of the knee is normally limited by the anterior crucial, internal and external lateral ligaments. External rotation of the leg on the knee is limited by the lateral ligaments, but the anterior crucial ligament also limits internal rotation. Flexion is limited by contact of the calf with the back of the thigh. After injuries to the knee joint, any of these movements may be restricted owing to the joint being distended with fluid or by a mechanical obstruction such as a loose body or displaced semilunar cartilage.

DIAGNOSIS

History. A clear and accurate history of the nature of the accident is essential. Consideration of the particular injury will show that it is important to determine the exact sequence of events when the accident occurred. How the accident happened, the question of locking, the rapidity of disablement, and a history of previous accidents to the joint are all to be noted.

Examination. A definite routine is necessary in this or any joint injury. Whatever routine is followed it is very valuable to determine

at an early point in the examination if the patient's condition is definitely the result of the accident, but this should not bias the opinion before the examination is completed.

The patient is seated comfortably on a couch with both legs and thighs stripped, for comparison of the two limbs is essential. Note is made of any bruise or enlarged veins; the condition of the muscles of the two thighs is compared; the position and extent of any swelling is noted; and the temperature of the two knee joints is compared.

The joint is then tested for fluid by the usual method, with the hand above and below the patella and by testing if the patella tap is present. The presence of a small amount of fluid is not readily detected by either of these methods. It can be tested by placing the palm of the hand against one side of the joint, so as to press away any fluid in the lateral part of the synovial cavity; when the hand is removed, the hollow at the side of the joint will fill up if a small quantity of fluid is present. If the hollow remains the same, the opposite side of the joint is stroked so that the fluid is often pressed back again into the hollow.

Movements. Movements of the two limbs are compared. Particular attention is paid to any limitation of hyperextension if such is present in the normal limb. The limitation of flexion is measured in degrees or, if this is difficult, the distance between the tuber ischii and the heel can be measured. Limitation of flexion is seldom of assistance in determining the nature of an injury for it is frequently due to the quantity of fluid in the joint. The movements of the joint may be tested with the patient standing, when limitation of extension is often easily determined, and limitation of flexion is shown by the extent to which the patient can do a double knee bend.

Stability of the joint. The lower end of the thigh is grasped with one hand and the leg with the other, in order to test the antero-posterior stability. The limb is kept straight, but an attempt is made to move the leg forward and backward on the lower end of the femur. The slight movement normally possible is greatly increased by any laxity of the anterior crucial ligament. Lateral mobility is tested by moving the leg inward and outward at the joint. A complete tear of the internal lateral ligament will allow a considerable degree of outward movement and pain will be caused in most injuries on the inner side of the joint. The patient bends the knee now, so that the sole of the foot is resting flat on the couch. Note is made of any tender spots and the exact situation of such tenderness is marked with a skin pencil.

Tenderness near the patellar ligament is more commonly due to fat or synovial injury than to a lesion of a cartilage, whereas the cartilage injuries produce tender spots somewhat more laterally.

The hand is placed on the knee which is bent to and fro to ascertain if creaking is present in the joint. The popliteal space is examined for tenderness or swelling.

X-ray examination. This is a routine part of the clinical examination and should never be neglected. Unexpected lesions such as a fracture of the tibial spine or the presence of a loose body may be shown, although the clinical examination did not suggest such a lesion.

INJURIES

It is important to diagnose what structure of the knee joint has been injured by an accident, and to avoid the term "synovitis" which in the majority of cases is the secondary result of the injury.

In young patients the most common injuries are tears of the internal lateral ligament and internal semilunar cartilage. In middle age and elderly patients injury to peri-synovial fat or rupture of adhesions in a joint already osteo-arthritic are more frequent.

INJURY TO THE INTERNAL LATERAL LIGAMENT

(a) The force which puts strain on this ligament is abduction of the leg in slight flexion when the foot is everted. Consequently, if a weight falls on the outer side of the knee when the leg is in this position, injury is likely to occur; there need be no question of twisting of the joint. Such an injury causes a tear of the deep fibres of the ligament at their attachment to the margin of the tibia.

(b) Separation of the upper or lower attachment of the ligament from the femur or tibia may occur when the leg is forcibly abducted at the knee. This injury is more common in industrial accidents than at sport, and the symptoms and signs are different from those of a tear of the deep fibres.

The Symptoms, Signs, and Treatment of the two conditions differ :

(a) *Pain* is caused by stretching the internal lateral ligament and is situated at the upper border of the tibia on the inner side. *Tenderness* along the line of the ligament at the upper border of the tibia is present.

Locking does not occur.

Fluid is present in the joint.

Treatment. Splinting of the knee so that it is kept extended and the inner side of the joint not stretched. This is carried out most comfortably by means of a plaster cast extending from the top of the thigh to the ankle, fitting the posterior half of the limb so that the anterior half is uncovered. A pressure bandage can be used in addition, to control the effusion. It will be necessary to wear a splint for three weeks, but physical treatment should be employed to keep the muscles efficient throughout. At the end of three weeks, active movements of the knee can be started, but the patient need not lie up and can walk in the plaster cast as soon as it is firm.

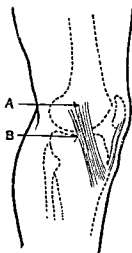


Fig. 1905.—DIAGRAM OF LATERAL VIEW OF KNEE JOINT.

A. Site of tear of internal lateral ligament from femur.
B. Site of tear and pain in injury to deep fibres at their attachment to the margin of the tibia.

(b) *Pain* is in the knee joint (owing to the effusion) and on the inner side at the site of the rupture, usually the femoral condyle.

Tenderness is at the site of the injury.

Effusion is considerable.

Bruising is often sufficient to extend down the leg. The leg can be abducted at the knee to a considerable extent. An X-ray will exclude the presence of a fracture into the knee joint, and may show the increase in the joint space below the internal condyle of the femur.

Treatment. In a young patient, operative repair is necessary when the tear is complete. This is indicated by it being possible to abduct the leg on the femur for 30° or so. Operative treatment is desirable if the leg cannot be brought into the normal alignment with the thigh. At the operation it is sometimes found that the internal semilunar cartilage has been drawn down from its normal position. It is therefore advisable that this should be inspected before the torn portion of the ligament is sutured to its normal position.

In the majority of cases, and in all elderly patients, a splint is applied for four weeks and physical treatment employed. When the patient wears a shoe after this injury the inner side of the heel should be wedged, to relieve the strain on the inner side of the knee joint.

Prognosis. Efficient treatment carried out soon after the injury should result in a perfect knee in slight cases. The serious tears are not followed by a normal knee, and a tear when the knee is already arthritic is likely to be followed by progress of the arthritis.

In neglected cases, when instability and recurrent effusions occur, reconstruction of the internal lateral ligament should be considered. The operation of choice should be based on that described by Edwards (*British Journal of Surgery*, VIII, 1920).

The principle of the operation is making use of a distal portion of the tendons of the gracilis and semitendinosus muscles as a lateral ligament.

EXTERNAL LATERAL LIGAMENT

This is seldom injured, probably because the force of injury is more liable to fracture the upper end of the head of the fibula. Direct injury or severe adduction and internal rotation of the knee may cause the ligament to be torn from the head of the fibula.

Symptoms and Signs. Pain over the top of the fibula; effusion into the joint seldom occurs. X-ray excludes a fracture of the fibula.

Treatment. This consists in keeping the knee straight on a splint for three weeks. Physical treatment is employed. A good knee is to be expected.

In rare cases in which instability results from neglect of an external lateral ligament injury, a reconstruction operation can be performed comparable to that used on the inner side of the knee. In these cases a new ligament is formed out of fascia lata or the tendon of the biceps.

INJURY TO THE INTERNAL SEMILUNAR CARTILAGE

Ætiology. This injury may occur at any age, but is most common amongst athletes, particularly footballers, and amongst miners.

The usual mechanism of the injury is a twist of the leg outwards when the thigh is fixed, or a twist of the thigh inwards on the leg when the leg and foot are fixed. In either case the knee is invariably in a semi-flexed or flexed position. If the knee has never been injured before, a slight injury will not be sufficient to tear a cartilage and displace the torn portion so as to lock the knee, but when a knee has been injured a number of times, it may become locked if twisted in the ordinary routine of life by such a movement as getting from the

sitting position on the floor. When the term "locking" is used, it should be confined to limitation of flexion or extension (usually the latter) due to mechanical obstruction, so that when the patient is under an anæsthetic and the knee is gently flexed or extended, the full movement is not obtainable. .

EXAMINATION

(a) *Tear of a cartilage* in a knee which has not been locked. This injury produces an effusion into the joint, and tenderness in the triangle on the inner side of the joint formed by the upper border of the tibia, the inner border of the patellar ligament and the inner border of the internal condyle of the femur. Tenderness may be present over the internal lateral ligament at the joint level or at the back of the joint on the inner side. Movement is only limited by the extent of the effusion.

(b) *Locked knee* due to tear of this cartilage. Full extension cannot be obtained. If the normal knee will hyperextend 5 degrees, the injured knee can usually be extended nearly to the straight line, that is to say, 10 degrees less than on the normal side. If the normal knee cannot be hyperextended, the locked knee will only extend to 170 degrees and full flexion is not usually obtained. Effusion is present and tenderness usually in the triangle already indicated.

The locking is due to a bucket-handle cartilage or to the anterior half of the cartilage being displaced more into the centre of the joint so that the condyle of the femur cannot rotate fully on the tibia during the normal mechanism of extension.

If the joint has been locked a number of times, the signs are somewhat modified. A smaller effusion is usually present, often insufficient to fill up the supra-patellar pouch. The vastus internus may be considerably wasted. Tenderness can usually be found. The patient may say that movement is quite free, but examination will show that the last few degrees of extension are not obtainable if the joint is still locked.

(c) *Recurrent injury to the knee* seen as "an interval case." This means that the patient seeks advice some weeks or months after the last injury. This type of case is relatively common. Great importance must be laid on the history, and every attempt should be made to ascertain from the patient the mechanism of the first and subsequent injuries. The author considers that if examination of the knee shows nothing abnormal, the patient should be told to seek advice imme-

diately after a further injury. However, if one finds a small quantity of fluid and tenderness in the typical place, associated with wasting of the vastus internus, there is sufficient evidence of a cartilage injury, provided the history points to this lesion. Full movements are to be expected if the patient describes that he has unlocked the joint, or has had this done by someone else since the last injury.

In every case of a knee injury, particularly when a cartilage injury is suspected, a skiagram must be taken to exclude certain conditions which are mentioned under the differential diagnosis.

Differential Diagnosis. The history of the accident is of considerable importance. The first essential in diagnosis is to exclude lesions of the rest of the joint and to limit the diagnosis to that of a cartilage injury. The type of cartilage injury is of interest chiefly to the surgeon and is really of no interest to the patient except in those cases when non-operative treatment is advised.

An inflammatory condition of the joint must be excluded. One refers particularly to tubercle. The author has seen two cases in which there was a history of injury, and although movements were full and pain limited to the inner side with considerable effusion, exploration was only advised after some delay. In both cases a tentative diagnosis of a lesion of the internal semilunar cartilage was made and synovial tubercle found at the operation.

Traumatic arthritis can usually be seen in the X-ray as soon as the patient complains of the joint. The symptoms described by the patient are usually somewhat vague—irregular pain and stiffness and a feeling of insecurity of the joint. Fluid and coarse grating are usually present, and full extension may give rise to pain. The patient gets on all right for the routine of life, but the joint gives him trouble when it is over-used.

A loose body will be revealed in an X-ray, provided that it contains some osseous tissue. The outline of a pure cartilaginous loose body is sometimes visible in the X-ray but is not necessarily seen. This may cause locking and give rise to difficulty in diagnosis unless felt or seen in the X-ray. The lesion, osteochondritis dissecans, is recognized by the X-ray but seldom clinically. Although the signs of internal lateral ligament lesions differ from those of a cartilage injury, the two may be confused. It is probable that the diagnosis is a cartilage injury if the treatment carried out for the internal lateral ligament injury has not cured the condition. A nipping of the retro-patellar fat pad is quite frequently mistaken for an injured

cartilage. Details of this injury, as described subsequently, should enable a differential diagnosis to be made.

Intra-articular fractures and injury to the crucial ligaments should not be confused with a cartilage lesion.

The cases causing greatest difficulty in diagnosis are those in which the pain is situated at the joint level posteriorly, on the inner side. Sometimes this pain is due to periodic distensions of the semimembranosus bursa; this will occur whenever there is a distension of the joint with fluid if there is communication between the bursa and the joint. Lesions of the posterior part of the internal semilunar cartilage produce pain in this situation and often limit full flexion of the joint. The diagnosis of a tear of the posterior part of the cartilage is confirmed by a manipulation on which McMurray has laid great stress. "If the knee joint is fully flexed so that the heel is placed almost on the buttock, then abduction of the leg and external rotation of the foot will bring to bear on the internal cartilage the exact strain as occurs in the accident when the internal cartilage is displaced or torn. With the foot and leg held in relation to the thigh, the knee is then slowly extended. If there is a lesion of the internal cartilage at any spot from the level of the attachment of the internal lateral ligament *backward*, a distinct click will be produced when the femur passes over the site of the injury in the cartilage."

Treatment. When the diagnosis of an injury to the internal semilunar cartilage has been made, there are three possible lines of treatment:

(1) Non-operative.

(2) Operative (a) by manipulation only,
(b) by open operation.

(1) *Non-operative.* The indications for this line of treatment are:

(a) A patient of any age has had only one injury to the cartilage, the joint is not locked on examination, and the knee is causing no trouble;

(b) A middle-aged or elderly patient has had one or more injuries to the cartilage, the knee is not locked, and there is a condition of arthritis present in the joint.

Non-operative treatment consists in wearing a pressure bandage if effusion is present, and treatment by faradism to the quadriceps together with exercises. The patient is warned to take care to avoid such twists as may produce a further lesion of the cartilage.

(2) *Operative.* (a) *Manipulation.* When the joint is locked this is indicated as a measure to undo the locking. It is recommended when a knee is locked for the first time, and when a patient has had a knee locked a number of times and is anxious to avoid immediate operative treatment. It should be explained to the patient that manipulation is usually but not necessarily successful in reducing the locking, but that it will not cure the cartilage lesion, and that locking may recur. It is probably worth while carrying out the manipulation on the occasion of the first locking, as there is no doubt that some knees lock only once and never again. However, if the knee has been locked twice or more often, further recurrence is probable, and manipulation is only carried out to make the knee more comfortable for the time being.

Technique. Complete relaxation of the limb is necessary for less than half a minute. In the majority of cases a competent anaesthetist will obtain this with nitrous oxide and oxygen anaesthesia. The patient lies recumbent; the operator stands on the right side of the couch, the leg is held firmly and the thigh flexed at the hip joint. The leg is then rotated outwards on the femur and slowly flexed at the knee so that the space on the inner side of the knee joint is enlarged. Sometimes the cartilage will slip in with a click when full flexion is obtained. If nothing occurs on full flexion, the leg is extended and rotated inwards quickly, both movements taking place concurrently. It will be recognised that the cartilage has slipped off the lateral aspect of the medial

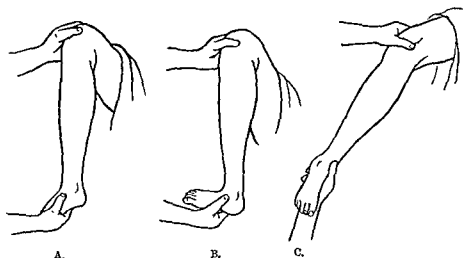


Fig. 1906.—DIAGRAMS TO INDICATE MANIPULATION OF THE RIGHT LEG TO REDUCE A DISLOCATED INTERNAL SEMILUNAR CARTILAGE. A. THE LEG IS GRASPED AS SHOWN, THE KNEE IS FLEXED. B. THE KNEE IS MORE FLEXED, THE LEG EXTERNALLY ROTATED AND ABDUCTED. C. THE LEG IS EXTENDED AND INTERNALLY ROTATED, TRACTION BEING APPLIED WITH THE RIGHT HAND AT THE SAME TIME.

condyle of the femur by the fact that full extension is obtainable and that the knee does not feel springy in full extension. A pressure bandage is then applied and physical treatment employed if there is quadriceps inefficiency.

(b) *Operation* is indicated :

- (1) When manipulation has failed to reduce a locked knee ;
- (2) When the knee has been repeatedly locked and is at the time of examination either locked or not ;
- (3) When a tear has been diagnosed although the joint has not necessarily been locked ;
- (4) When the nature of the injury and the signs present suggest an injury to the cartilage, but there has been a certain doubt about this and other treatment has failed to cure the condition.

The principal *contra-indications* to operation are multiple arthritis and those conditions for which physical treatment was advised under Non-operative Treatment.

The object of operative treatment is to cure the symptoms caused by the cartilage lesion and to prevent or delay the onset of traumatic arthritis.

The removal of an abnormal cartilage will leave a joint which is normal or very nearly so, provided there is no trace of arthritis, that the ligaments are strong and of normal laxity, and that there is no effusion of long standing.

Technique. The operation should only be performed under perfect surgical conditions. Skin preparation should be carried out for forty-eight hours before the operation ; a tourniquet should be applied.

Skin incision. This must be planned so that there is no damage to the internal lateral ligament or patellar ligament. The length of the

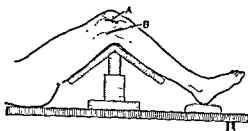


Fig. 1907.—THE KNEE PLACED ON A REST FOR OPERATION ON INTERNAL SEMILUNAR CARTILAGE.

- A. Indicates incision on the front of the joint for removal of the cartilage.
- B. Indicates incision used for exposure of the posterior half of the cartilage.

incision is frequently discussed. One group of surgeons consider that a large incision is necessary in order to inspect as much of the knee joint as possible, whereas the majority consider that the incision should be sufficiently long to enable the cartilage to be removed without difficulty, and no longer. Consequently, the incision of choice is one between two and three inches long only and parallel to the inner border of the patella and infra-patellar ligament. A curved incision with the convexity downwards, extending from near the lower border of the patella downwards and inwards to the front of the internal lateral

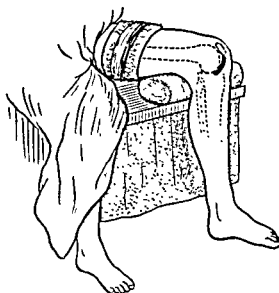


Fig. 1908.—THE LIMB IS PLACED WITH THE KNEE AT A RIGHT ANGLE OVER A SAND-BAG, FOR OPERATION FOR REMOVAL OF THE INTERNAL SEMILUNAR CARTILAGE. THE CURVED INCISION USED IN THIS POSITION IS SHOWN.

ligament (fig. 1908) is often used. It is stated that the patellar branch of the internal saphenous nerve may be divided by this approach.

Naughton Dunn considers the division of this nerve inadvisable, as a fibroneuroma may develop, but the possibility of this complication is so rare that it is insufficient to justify the exclusion of this incision from the good approaches to the knee.

The latter incision is the better one if the operation is performed with the knee hanging over the edge of the table, whereas the more vertical incision is an easier approach when the knee is placed over sand-bags or a knee-rest. The skin and subcutaneous tissue are separated from the capsule and skin veils are applied, retractors are placed in the wound and the capsule is incised downwards and inwards as indicated in the diagram. The next layer of tissue is the extra-synovial fat in which are situated two blood-vessels crossing the line

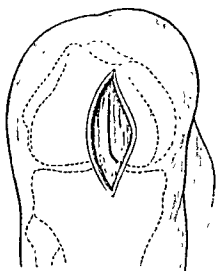


Fig. 1909.—OPERATION FOR REMOVAL OF INTERNAL SEMILUNAR CARTILAGE. THE CAPSULE HAS BEEN EXPOSED, THE DARK LINE INDICATES THE INCISION INTO THE CAPSULE IN THE LINE OF ITS FIBRES

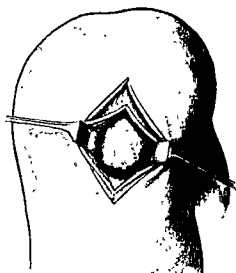


Fig. 1910.—THE CAPSULE IS RETRACTED EXPOSING THE MEDIAL CONDYLE AND ANTERIOR PORTION OF THE INTERNAL SEMILUNAR CARTILAGE.

of incision, even when the incision of the capsule is less than $1\frac{1}{2}$ inches long. As the blood-vessels come into view, they are clipped and the fat and synovial membrane divided. If there is excess of synovial fluid it will now flow out of the joint. Retractors are placed round the synovial membrane and the joint is inspected.

(1) *A bucket-handle cartilage is seen.* There is a choice of two operative procedures:

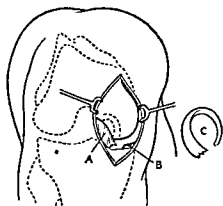


Fig. 1911.—DIAGRAM TO INDICATE BUCKET HANDLE CARTILAGE IN SITU.

- A. Anterior portion winding round the external surface of the medial condyle.
- B. Portion of cartilage remaining on tibia.
- C. Whole length of bucket-handle cartilage shown.

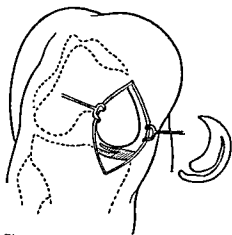


Fig. 1912.—DIAGRAMMATIC APPEARANCE OF TORN CARTILAGE. TYPE OF TEAR IN THESE CASES IS SHOWN.

(a) To divide in front the strip of cartilage which is displaced and then to grasp the torn end, apply slight traction to this, and to divide the posterior end of this displaced portion with a thin knife or strong tenotome.

(b) To carry out the procedure described under (a) and then to remove the remainder of the cartilage. It is probable that removal of the displaced portion alone will cure a number of knees, but that further trouble will occur in some in which the remainder of the cartilage is left behind. It is the author's practice to inspect the remainder of the cartilage; if this seems firmly attached and has no tags, it is left *in situ*.

(2) *A bucket-handle cartilage is not present.* If the anterior horn is seen to be torn, the whole of the cartilage is removed by use of a short knife or tenotome. Incision commences in front, leaving about a millimetre of cartilage along the rim; when a portion is free, this is grasped with Kocher's forceps in the left hand and the incision is carried backward; when the cartilage is free from the medial side of the joint, traction will slip the cartilage laterally into the centre of the joint, and the posterior horn is divided.

Supposing that no lesion of the anterior horn is visible this is divided in a similar way, and the operation of separating the cartilage is similarly performed because it is impossible to see a tear of the posterior part of the cartilage until it is drawn forward.

Closure of the Joint. It is most important to close the joint carefully, however small the incision has been. The edges of synovial membrane should be turned outward slightly and accurately united. This can be done by means of a blanket stitch passing through synovial membrane and sub-synovial fat. When the opening into the joint has been closed, the same stitch is carried through the capsule, which is joined with an "in-and-out continuous stitch" of the type called Glover's suture; the end of the gut is tied to the loose end from the deep stitch. The skin is closed, a pressure bandage is applied, consisting of three layers of cotton wool placed in layers between a calico bandage, and the tourniquet removed. The limb is placed on two pillows in bed; the patient requires morphia the first night.

After-Treatment. The objects are:

- (1) To enable the muscles to regain their normal strength.
- (2) To prevent effusion, or to aid its absorption if it has formed.
- (3) To regain full movement.

The treatment of the muscles consists in making the patient contract his quadriceps with the help of artificial stimulation with the faradic battery, and, after ten days, exercises. The effusion is controlled by a pressure bandage, which should be worn day and night for two weeks, and for longer if an effusion persists. After that, the patient has more confidence in his knee if he wears a firm bandage for another month. Crêpe velpeau and elastic knee-caps are of no value. If the muscles

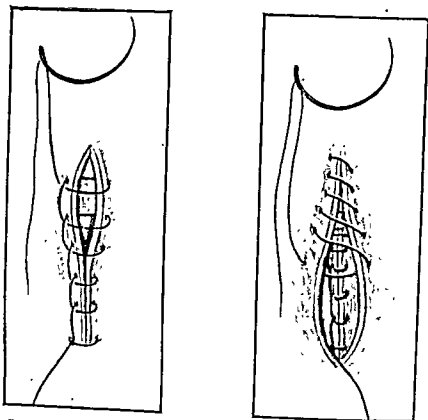


Fig. 1913.—METHOD OF SUTURE OF SYNOVIAL MEMBRANE, BLANKET STITCH BEING USED, THE END OF THE CATGUT IS BROUGHT THROUGH THE CAPSULE SO THAT THE LATTER IS CLOSED WITH THE SAME STITCH BY THROUGH-AND-THROUGH SUTURES.

and effusion are attended to, full movement will return, and, in fact, is usually present at the end of three weeks. The routine which may be followed is :

4th day after operation. Make the patient contract his quadriceps for a few minutes every hour. The pressure bandage should not be removed, unless it gets loose. It is seldom possible to reapply it as tightly as was done on the operating table.

6th day. The patient should lift the leg up and down with the leg fully extended, raising the heel one foot from the bed.

8th day. Stitches out. Patient can sit in a chair with the leg up.

9th day. Patient up: walking with a splint on the back of the thigh and leg. Half an hour's treatment with faradism.

10th day onwards. Walk without splint, faradism and exercises. This treatment is continued for a time, depending on the condition of the muscles before operation and the effusion produced in the joint. Treatment twice a day is the ideal, and six times a week the minimum that should be ordered. Convalescence is shorter if there is little fluid before the operation and if the muscles are in good condition. Consequently some advocate that the muscles should have treatment before the operation, and that faradism should be begun four or five days after the operation.

APPROACH TO AND REMOVAL OF THE POSTERIOR PART OF THE INTERNAL SEMILUNAR CARTILAGE

There are three indications for approaching the inner side of the back of the joint:

(1) When the anterior two-thirds of the cartilage have been removed, and symptoms and signs arise which indicate that the posterior portion of the cartilage is the cause of the trouble.

(2) When it has not been possible to remove the back of a cartilage through an anterior incision and it is known that the posterior part is the cause of the trouble.

(3) In some cases when there has been an injury to the cartilage and the posterior part of the cartilage is palpable behind the internal lateral ligament.

This operation is not often required, and it has already been indicated that it may be necessary in conjunction with the anterior incision or apart from it. When it is required in conjunction with the anterior incision, the latter should be closed before making a new opening.

TECHNIQUE OF OPERATION

The limb is placed over a rest so that the femur and tibia are at a right angle. An incision is made on the medial aspect of the knee along the anterior border of the sartorius muscle (see fig. 1907). This incision lies one inch behind the adductor tubercle; the lower end of the incision extends about one inch over the back of the head of the tibia.

The anterior border of the sartorius is defined and drawn backward, the posterior border of the internal lateral ligament is then defined and the upper surface of the tibia is recognised by feeling for a gap between the femur and tibia. The synovial membrane and the loose capsule

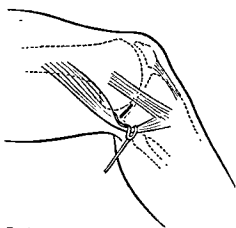


Fig 1914.—DIAGRAM OF INNER SIDE OF THE KNEE JOINT TO DEMONSTRATE THE INCISION INTO THE POSTERIOR PART OF THE CAPSULE OF THE KNEE JOINT ON THE INNER SIDE. SARTORIUS MUSCLE IS RETRACTED; THE DARK LINE SHOWS THE INCISION MADE THROUGH THE CAPSULE BEHIND THE INTERNAL LATERAL LIGAMENT.

are picked up and opened at the joint level behind the internal lateral ligament. The opening of one inch or more into the joint is easily made.

The posterior portion of the cartilage is easily recognised. If there is still an attachment to the tibia by the coronary ligament, or to the internal lateral ligament, this is divided. Its removal is completed by division of the posterior cornu as close to the tibia as possible. The pouch of synovial membrane just on the back of the tibia on the inner

side is well seen through this incision. The wound is closed in two layers, first the synovial membrane and then the capsule. The *after-treatment* is similar to that for any operation on a cartilage.

This operation is quite simple, provided an efficient tourniquet is used, but is only suitable for removal of the posterior part of the cartilage.

INJURY TO THE EXTERNAL SEMILUNAR CARTILAGE

It is customary to describe the symptoms, signs and treatment of injury to the semilunar cartilages, and only to separate lesions of the internal and external semilunar cartilages when the lesions of the two sides differ completely. Although in some cases the lesions present comparable signs it is advisable to place injuries on the outer side of the joint in a separate category.

The external semilunar cartilage is a more complete disc than the inner one. It is attached firmly to the upper surface of the tibia by the anterior and posterior horns, and to the edge of the tibia by short fibrous bands called ligamenta coronaria. The internal cartilage is attached in a similar way. The external has a posterior attachment to the posterior ligament of the knee joint and another to the posterior

crucial ligament, whereas the internal semilunar cartilage has no attachment of this nature at the back of the joint. The external cartilage has no attachment to the external lateral ligament, and is separated from it by the tendon of the popliteus.

ÆTIOLOGY

The lesions of the external semilunar cartilage are much less frequent than those of the internal cartilage. Three types are recognised :

- (a) A tear of the cartilage.
- (b) Locked knee due to a tear of the external cartilage ; recurrent locking of the external cartilage is of doubtful occurrence.
- (c) Congenital abnormality—disc cartilage ; a comparable condition on the inner side is extremely rare.

The mechanism of production of a tear of the external cartilage is comparable to that of an injury to the inner cartilage ; in this case the knee is in flexion, but a twist occurs in the opposite direction,—the leg is rotated inward when the thigh is fixed, or the thigh is rotated outward when the leg is fixed.

Examination. (a) *A tear of the cartilage in the knee which has not been locked.* The patient states that the joint is useless and there is pain below and to the outer side of the knee cap. If there have been a number of injuries, the patient may say that the joint has got nearly well when the fluid has subsided, but that after each injury the joint has felt weak ; on the other hand, he may say that the joint clicks and, if observant, will have noticed that the click occurs just before the leg is fully extended.

There is fluid in the joint ; full extension and flexion will only be limited by great distension of the joint with the fluid. A diagnostic click may be felt or heard. It usually occurs within the last 10 degrees of full extension, that is to say, when the angle between the leg and thigh is 170 degrees. Further, if this click always occurs when the limb passes through this range of movement, the sign is conclusive of a tear of the external cartilage.

When the knee is bent to a right angle, there is a feeling of resistance in the triangle on the outer side of the knee formed by the outer border of the patellar ligament, the edge of the external condyle of the femur and the upper border of the tibia.

The history and examination, as stated, are conclusive evidence of a tear of the cartilage, but difficulty arises when the patient locates the pain at the back of the joint. If there is a history of clicking or of any obstruction to full range of movement and fluid is present in the joint, there is sufficient evidence on which to diagnose a tear. If there has not been mechanical obstruction nor clicking, it is advisable to tell the patient to report for examination immediately after a future injury.

Cases occur, however, in which the history suggests a tear of the cartilage when there is fluid in the joint and tenderness posteriorly without clicking or obstruction. Pressure on the back of the knee joint medial to the biceps tendon may produce pain on flexion and extension of the knee. Such a case usually proves at operation to be a tear of the back of the cartilage which could not be cured without operative treatment.

(b) *Locked knee due to tear of the external cartilage.* It is extremely rare to find that the knee cannot be straightened out,—in fact, has locked owing to displacement of the external semilunar cartilage. The anatomy of the locked cartilage is that the coronary ligament is torn from the outer surface of the tibia, and the cartilage is in a raised bucket-handle position still attached in front and behind. This is much more rare on the outer side than on the inner, partly because the knee is more liable to accidents on the inner side, owing to greater exposure to injury by a force applied to the outer side of the joint; but also from the anatomical arrangement, for the shape of the external cartilage does not lend itself to a displacement into the middle of the joint and the posterior attachment to the posterior crucial ligament is likely to be a factor in the prevention of this displacement.

There will be fluid in the joint, limitation of full extension, and tenderness in the triangle on the outer side of the knee. Pain in the knee from locking on the outer side is probably greater than that caused by locking of the internal semilunar cartilage.

Differential Diagnosis. It is probably more easy to be dogmatic in the diagnosis of a lesion of the external semilunar cartilage than of the internal cartilage. Lesions of the external lateral ligament are rare and when the lower attachment of this ligament is torn, usually a fragment of the head of the fibula is separated. Tenderness is elicited at the head of the fibula and the fractured piece of bone is visible in an X-ray. Cracks in the head of the tibia due to injury would likewise be seen in an X-ray. Tears of the synovial membrane alone are uncommon and the ilio-tibial band is such a strong tissue that it is rarely injured.

The fat pad in front of the joint, when injured, causes tenderness near the patellar ligament and tenderness may be present on both sides of the patellar ligament; effusion is usually slight.

The differential diagnosis between traumatic arthritis and lesions of the internal semilunar cartilage has been discussed. The difficulty in diagnosis arises more often when symptoms are on the inner side of the joint than when they are on the outer side. Possibly confusion between a loose body in the joint and a lesion of the external semilunar cartilage is not infrequent. The diagnosis of the loose body is generally possible from the skiagram. When there is a snap or click on the outer side of the knee, this is sometimes due to the slipping of a tendon over an exostosis at the top of the tibia or the upper end of the fibula.

(c) *Congenital abnormality.* The condition may be bilateral, the abnormality may consist of an unusual shape, or there may be unusual attachments:

(1) The common type is where the cartilage is a complete or nearly complete disc. Such a cartilage has no definite anterior and posterior horn, and the medial border may be almost a straight line; the outer border or periphery is usually abnormally thick.

(2) The cartilage may be represented by two pieces of fibro-cartilage united together by fibrous tissue; when this is the case, no coronary ligament is recognisable.

(3) The cartilage may be represented by fibro-cartilaginous tissue, having a peripheral attachment, and either an anterior or a posterior horn, but not both, so that the cartilage is about two-thirds the size of a normal cartilage, but usually considerably thicker.

Examination. The history usually commences with trouble in the knee in childhood. The mother may say that the knee used to snap or grate or that there was periodic swelling. At times the history will reveal similar trouble in both knees. These cases come for examination usually when the child starts playing games about the age of ten. Locking of a painless nature may be frequent. Pain may be situated in the front or the back of the joint. Effusion is not a prominent symptom or sign associated with this condition. Tenderness may be present in the front of the external cartilage. When an adult seeks treatment for a

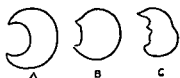


Fig. 1915.—EXTERNAL SEMILUNAR CARTILAGE.

- A. Average shape of normal cartilage.
- B. Disc cartilage.
- C. Irregular shaped thick cartilage.

lesion of the outer side of the joint, this condition may be considered if the history dates back to childhood, but it is impossible to state that a congenital abnormality is present in an adult without such a history.

The diagnostic feature of this condition in children is the ready production on active or passive movement of the snap on the outer side of the joint, which is of quite a different nature from the snap which many young persons can produce in many joints—capsular in origin and having no association with intra-articular lesions.

Treatment. When the diagnosis of an injury or congenital abnormality of the external semilunar cartilage has been made, operative treatment is indicated. To delay operative treatment is only advisable in those cases in which there is a doubt. Under such circumstances, the patient is advised to seek examination immediately a further injury occurs, so that the diagnosis can be settled. Torn external cartilages give rise to more recurrent trouble than internal cartilages; consequently, it is unlikely that the patient will be able to continue an active life without further mishap to the knee once the external cartilage has been torn.

Operation. This is carried out in a similar manner as that for removal of the internal semilunar cartilage; the incision may be parallel to the outer border of the patella, or be a slightly curved one extending from one inch within the lower angle of the patella to half an inch below the tibial margin. The details of the remainder of the operative procedure differ in no way from the operation for removal of the internal cartilage.

CYSTS OF SEMILUNAR CARTILAGES

Cysts occur in both the external and internal semilunar cartilages. The condition is more common in males than in females, and the external cartilage is affected five times as frequently as the internal cartilage. It is most frequently seen between the ages of twenty and forty. It is recorded in a boy of six, and I have seen one in a woman of sixty-six.

Symptoms and Signs. There is usually a history of a fall, twist, or direct injury to the knee, often about six months prior to the onset of the symptoms. The patient complains of pain on one or other side of the knee and the presence of a swelling. The knee often gives way.

Examination shows a swelling situated at the level of the joint, usually the size of a walnut ; it is not attached to the skin, and is most prominent when the knee is flexed to a right angle. The swelling feels firm and attached to the deep structures, but cannot be reduced entirely into the joint. There is often a small effusion into the joint cavity. Movements are seldom restricted, but full flexion may not be obtainable.

Ætiology and Pathology. The cause of the condition is not known, but a history of injury is so frequent that it cannot be neglected as a possible cause. Examination of a cartilage removed with its cyst shows that the peripheral portion of the cartilage is mainly affected. The



Fig. 1916.—EXTERNAL SEMILUNAR CARTILAGE, A SINGLE CYST.



Fig. 1917.—SECTION OF AN EXTERNAL SEMILUNAR CARTILAGE SHOWING A CYST WHICH HAS SEPARATED THE CARTILAGE INTO TWO LAYERS AT ITS PERIPHERY.

cyst may be unilocular or more often multilocular. The cyst contains clear gelatinous material and the wall is thin and white. It may be attached on the outer side to synovial membrane and sometimes to the capsule. The relationship of the cyst to the cartilage differs in a number of specimens ; it is almost constantly round the periphery, but at times appears to separate the cartilage into two layers, so that a section through the cartilage shows the cyst surrounded by fibrocartilage, except on the periphery.

It would appear that the cyst takes the line of least resistance and so projects on the periphery. Microscopic section shows a very definite flattened endothelial lining, probably similar to synovial membrane endothelium.

A history of trauma and the microscopic examination of the cyst are the only factors which assist in determining the origin of these cysts.

The suggestions put forward, therefore, are myxomatous degeneration of cartilage consequent on the injury—a condition comparable to the probable origin of the simple ganglion—or a degeneration resulting from hæmorrhage. In view of the avascular condition of the cartilage, the latter seems improbable. Other observers consider that the cysts may be congenital in origin, owing to the multiplicity of the cysts and the presence of papillary synovial inclusions without cyst formation which are shown in some microscopic sections.

Treatment. The condition will be cured by removal of the semilunar cartilage and cysts. The prognosis after this operation is excellent. In the process every effort should be made to remove as little synovial membrane and capsule as possible. It is usually possible to preserve the capsule of the joint, but it may be difficult to close the synovial membrane accurately.

A small incision such as is used for removal of a semilunar cartilage is not suitable for the operation of removal of a cartilage and cyst. An incision is planned with the convexity downwards and outwards, so that a flap can be turned up with the cyst lying in the centre. The capsule is incised vertically in front of the cyst and an incision, at right angles to the previous one, is made above the level of the cyst. The flap of capsule is turned down, and the synovial membrane is incised in front of the cyst, so as to expose the cartilage.

Dissection is then carried out, freeing the cyst from the surrounding structures and separating the attachments of the cartilage. The synovial membrane and capsule are closed in two layers.

The *after-treatment* of the case is similar to that employed after removing a cartilage.

LOOSE BODIES

The condition of one loose body or more in a knee joint is recognised by a movable lump being felt by the patient or surgeon, or by being visible in a skiagram. Loose bodies are of variable shapes, sizes and consistency. They were first recognised by John Hunter and are due to many causes. Timbrel Fisher's classification shows the variety of causes.

Group I. Loose bodies occurring in a joint affected with :

- (a) Osteo-arthritis and Charcot's disease.
- (b) Tuberculosis.
- (c) Acute arthritis due to infection.

Group II. Loose bodies occurring in the joint otherwise apparently normal.

- (a) Those having microscopic and often gross appearance of detached portions of articular cartilage including osteochondritis dissecans.
- (b) Those derived from intra-articular cartilages such as semilunar cartilages.
- (c) Those formed from a detached epiphysis not forming portions of an articular area. (Rare in the knee joint.)

Group III. Synovial chondromata, either laminated or non-laminated; such loose bodies may be single or multiple.

In young patients, loose bodies in the knee joint are generally due to detached portions of a semilunar cartilage or articular cartilage; in the latter case a small portion of bone is usually adherent to the detached articular cartilage. In middle aged and elderly patients, loose bodies in the knee joint are usually associated with osteo-arthritis. Other loose bodies in the knee joint are rare.

It is more than interesting to consider the origin of these loose bodies in some detail before describing the clinical aspects resulting from their presence in the knee joint.

Group I. In osteo-arthritis, osteophytic formation is relatively common, particularly around the patella and at the edges of the condyles of the femur. The osteophyte may become detached and examination of such a loose body shows it to consist of fibro-cartilage containing areas of hyaline cartilage and cancellous bone. It is seldom that more than three such loose bodies are present in one joint, but they may be of considerable size, particularly in Charcot's joints.

Group II. Portions of articular cartilage are detached most frequently from the knees of males and usually from the medial condyle near the intercondylar notch. It is probable that injury is the cause of these loose bodies. Possibly trauma to an area of an articular cartilage produces injury to the blood supply of the underlying bone. In consequence, the area of bone cut off from its blood supply separates with the articular cartilage covering it. This separation takes some time and during the process the articular cartilage is spongy. When separation has occurred, the loose body is usually oval, the convex surface is more flattened than the normal articular surface and may

somewhat pitted, and a flake of bone is visible on the concave surface. Articular cartilage may be separated without any underlying bone. The cartilaginous portion of such loose bodies grows in size, probably owing to nutrition from synovial fluid. When a flake of



Fig 1918.—DIAGRAM OF THE LOWER END OF THE FEMUR SHOWING AREA COMMONLY AFFECTED BY OSTEOCHONDRITIS DISSECANS AND TWO VIEWS OF THE LOOSE BODY WHICH HAS COME FROM THE AREA AFFECTED.



A.



B.

Fig. 1919.—LOOSE BODY REMOVED FROM KNEE JOINT. A. LARGEST SURFACE. B. SECTION. THE CENTRAL PORTION CONSISTS OF BONE WHICH IS SURROUNDED BY RAISED AREAS OF CARTILAGE.

bone is present, this does not grow but becomes almost entirely surrounded by pitted cartilage, which has increased in size.

Detached portions of a semilunar cartilage do not grow when free in the cavity of the joint.

Group III. It is probable that synovial chondromata arise from cartilage cells of the villi. They may be firmly attached to synovial membrane, held to it by a pedicle, or lie free in the joint.

SYMPTOMS AND SIGNS

Type I. The patient says that he has had no trouble in the knee of which he is aware, but finds a movable body in the joint. He may be able to find the loose body in the supra-patellar pouch and demonstrate it to the surgeon, or he may say it only comes to notice at times, so that the surgeon may be fortunate to feel it; otherwise it may be proved only by a skiagram.

Type II. The history is that the joint definitely locks, but only for a short time. Reduction of the locking is easily obtained by any movement of the knee; again, the loose body may be palpable by the patient and surgeon, or may only be found after prolonged examination and in a skiagram.

Type III. This may be termed a problematical knee, in that the symptoms suggest mechanical obstruction, with pain sometimes on one side, at other times on the other side, or at the back of the knee. Such a history is against an injury to one cartilage only. After each locking there is an effusion into the joint; when this is absorbed the knee may give no trouble until a further locking occurs.

Examination between types of locking may show a small quantity of fluid but no local tenderness. If a loose body is not palpable and does not show in the X-ray (owing to its composition being cartilage only), the diagnosis cannot be made until the loose body is felt.

Type IV. The symptoms point to a lesion of the internal semilunar cartilage, and X-ray examination shows a pit on the medial condyle of the femur and possibly the loose body detached from this pit. The diagnosis is osteochondritis dissecans with a loose body in the joint. Such a condition of the outer condyle is extremely rare.

The cases described in these four groups occur in the first half of life. The loose bodies will only show for certain in a skiagram if bone is present. The outline of a loose body formed of cartilage only is, however, frequently visible. Additional assistance is obtainable by the injection of an opaque fluid, such as uroselectan, into the joint prior to X-ray examination.

Type V. The patient states that he knows he has had "rheumatism" in the joint for some time, but has been able to put up with this



Fig. 1920.—A.P. AND LATERAL X RAY OF OSTEOCHONDRITIS DISSECANS. THE LOOSE BODY INVISIBLE IN THE MIDDLE OF THE JOINT.

until the joint began to lock or he found limitation of movement. Examination usually shows that there is osteo-arthritis in both knee joints, evidenced by fluid and grating in the knee joint of which the patient complains. One or more loose bodies may be palpable, and lip-ping may be present on the patella and at the lower end of the femur.

Treatment. X-ray examination is essential before treatment is advised, because if one loose body can be felt, it is important to discover if others are present in the joint.

In the first half of life, loose bodies should always be removed from the joint if they give rise to symptoms. A loose body left in a joint over a number of years will not only give periodic trouble to the patient by locking, but will cause grave damage to the joint by the production of osteo-arthritis, and by damage to synovial membrane and articular cartilage. The operation employed when the joint is free of osteo-arthritis depends on the situation of the loose body. It may be useful to X-ray the knee joint during the hour prior to operation with the



Fig. 1921.—X-RAY OF LOOSE BODY IN THE KNEE JOINT

limb fixed on a back splint, so that the loose body is less likely to move. If the loose body can then be fixed, its removal may be relatively simple if it is in the supra-patellar pouch. The assistant may grasp it between finger and thumb of the gloved hand, while the surgeon cuts down directly on it and removes it. Other surgeons transfix the loose body with a needle before removing it. If the loose body is at the back of the joint or at the side, the incision may be planned to cut down directly in either of these situations. A loose body placed in the lateral or posterior part of the knee is less likely to slide about during the operative procedure than one in the centre of the joint or in the supra-patellar pouch.

If the loose body is in the centre of the joint or the case is one of osteochondritis dissecans, the operation is planned as for removal of a cartilage. A vertical incision to one side of the patella is used for preference, but the approach to the joint by splitting the patella is unnecessary and destructive.

When severe osteo-arthritis is present in the joint, loose bodies should not be removed unless they are causing symptoms. An incision into an osteo-arthritic joint often causes the condition to progress so that removal of a loose body causing little trouble may leave the patient more crippled than he was before. However, large loose bodies or those causing frequent locking should be removed through as small an incision as is practicable, care being taken to fix the loose body before the skin is incised. Whenever possible the loose body should be removed by incision above the patella, for less damage is done to the joint by this approach than when the incision is at the joint level.

AFFECTIONS OF THE INFRA-PATELLAR FAT PAD

There is normally a fat pad in the space in front of the knee, deep to the patellar ligament. This pad of fat is covered on the deep surface by synovial membrane. When the knee joint is extended, the quadriceps moves the patella upwards and this pad of fat is flattened in an antero-posterior direction, so that it may bulge on each side of the patellar ligament.

In persons who are unduly stout, this pad of fat may take part in the general enlargement of the fatty tissues of the body. In a number of cases of osteo-arthritis there is a hypertrophy of the peri-articular fat, so that this particular fat pad may be affected. A normal fat pad may become nipped between the femur and tibia when the knee is extended, particularly if the quadriceps muscle is below par, but such

an occurrence is more likely when there is enlargement of this fat pad. If the fat pad is nipped, hæmorrhage may occur into its substance with œdema around it, so that the increase in size makes it more liable to further injury. A repetition of injury may produce fibrosis and hypertrophy of the fat pad.

Symptoms and Signs. The patient complains of pain in the front of the knee. This pain may be behind the patellar ligament, but is more often on one or both sides of this ligament and close to it (fig. 1922). The pain is produced by the patient straightening the knee and by passive extension, if there is hæmorrhage or œdema in the fat pad when the joint is examined. Flexion of the knee is full and painless; fulness is often present at the sides of the ligamentum patellæ at the site of the pain. This swelling may give the sensation of crepitation when the knee is moved to and fro. There are often recurrent effusions into the joint when the condition has been present for some time. There is no definite history of locking, and limitation of full extension is significant owing to the swelling of the pad of fat during the acute stage. Difficulty in diagnosis occurs immediately after the knee has given way, owing to the hæmorrhage into the pad of fat. At this time the condition may be confused with a cartilage injury, particularly if the pad is large and pain somewhat further away from the patellar ligament than is typical.

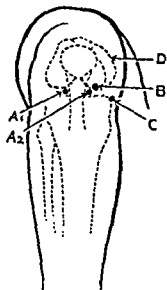


FIG. 1922.—DIAGRAM OF THE KNEE IN THE POSITION OF FLEXION VIEWED FROM THE FRONT.

- A1 and A2 are sites of pain in injury to the retro patellar fat pad.
- B. Site of pain in lesion of the internal semilunar cartilage.
- C. Site of pain in injuries to the deep fibres of the internal lateral ligament.
- D. Site of pain in rupture of the internal lateral ligament from the femur.

Treatment. (a) Non-operative, or (b) Operative.

(a) *Non-operative.* This treatment consists in employing physical methods to cause absorption of the hæmorrhage and œdema, and to limit further injury by mechanical means. The patient should be advised to avoid active exercise and to have radiant heat over the knee and faradism for the quadriceps. A knee-cage is fitted which should be worn day and night for some months to limit full extension. The lock should limit at least twenty-five degrees of extension. Raising the heel of the boot is not sufficient means of preventing full extension

in this type of case. Complete recovery may occur after non-operative treatment, but, if symptoms persist,

(b) *Operative treatment* should be employed. Incision is made on the inner border of the patellar ligament, and the fat pad removed. Faradism for the quadriceps should be employed subsequent to operation.

Injuries to the infra-patellar ligament and tendon of the rectus femoris are described in Chapter VI, "Muscle and Tendon Injuries."

SLIPPING PATELLA

Displacement of the patella may occur upwards in cases of paralysis of the quadriceps and in untreated ruptures of the patellar ligament.



Fig 1923.—DIAGRAM INDICATING FLATTENED EXTERNAL CONDYLE OF THE FEMUR WITH DISPLACEMENT OF THE PATELLA. THE THIN DOTTED LINE INDICATES COMPLETE DISLOCATION.

Inward displacement is described as occurring in association with severe genu varum. *Outward* displacement is the most common type, and is usually traumatic in origin.

The *outward* displacement may occur if there has been irregular development of the external femoral condyle, and in cases of severe rickets which have produced extreme genu valgum; in the latter cases the condition may be bilateral.

The only common type, which is termed *traumatic*, tends to become habitual; it is seen in girls of adolescent age more frequently than in boys. Genu valgum is usually present, and sometimes the whole knee joint is lax and the patellar ligament stretched. Owing to the knock knee, the quadriceps muscle draws the patella towards the outer side. A sudden action of the quadriceps or injury to the patella may cause the displacement of the patella on to the outer side of the joint. When

this displacement has occurred once or twice, the capsule becomes stretched and the displacement is liable to become habitual.

Symptoms. These vary considerably ; some patients will suffer a temporary disability only, whereas others find the knee joint distends with fluid on each occasion that the patella slips outward, even if it slides back again quite readily. Rarely the dislocation outward is so complete that the patient cannot reduce it herself. The quadriceps muscle tends to waste if there are recurrent effusions from frequent displacement of the patella.

Examination demonstrates the presence of knock knee in a proportion of cases ; the patella is often small and the capsule sufficiently lax to enable the patella to be moved further outward than is normal.

Treatment. Non-operative treatment is seldom of any benefit, and as soon as the diagnosis is clear, operative treatment is indicated.

- (1) If genu valgum is present, correction of this deformity will alone cure the slipping patella in a number of cases by altering the direction of the pull of the quadriceps.
- (2) If the capsule is lax, a further operation is necessary.
- (3) If there is no genu valgum, displacement of the tubercle is advised.

(1) In these cases the capsule is considered to be strong and unstretched, but as genu valgum is present osteotomy of the lower end of the femur above the condyles is practised. After the femur has been divided, the lower fragment of the femur should be rotated inward at the same time as the correction of the knock knee is carried out. The after-treatment can be carried out on a Thomas's splint with extension, or preferably in plaster of Paris until the skiagram shows that bony union is present. This procedure will cure a number of cases, but parents should be warned that a second operation may be necessary.

(2) The second operation consists in the displacement of the tubercle of the tibia further inward ; by so doing, the pull of the quadriceps will be straight and the patella will not slide up and over the prominent part of the external condyle of the femur. The operation is more effective if it is combined with a plastic one on the capsule of the knee joint.

Technique of Operation. A tourniquet is applied. A vertical incision is made from the inner side of the upper border of the patella downwards

along the inner border of the patellar ligament to a point $1\frac{1}{2}$ inches below the tubercle of the tibia. The periosteum and insertion of tendons on the inner side of the tubercle of the tibia are incised. By the use of a gouge, an oval-shaped area is cut to the inner side and below the level of the tubercle of the tibia. In size this is about one inch across and one-eighth of an inch deep. A thin chisel is then used to remove the patellar ligament and a thin slice of the tubercle of the tibia, sufficient bone being taken away to level off the front of the tibia. Slight dissection is made on each

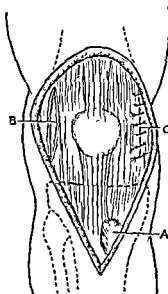


Fig 1914 — DIAGRAM OF KNEE JOINT TO INDICATE OPERATION USED IN SEVERE CASES OF SLIPPING PATELLA

- A. Area to which the tubercle of the tibia is transplanted.
- B. Incision on lateral side of the knee joint capsule.
- C. Plication of inner side of the capsule

side of the patellar ligament, and the loose tibial tubercle is then fitted into the new bed already prepared. When it is found that it fits neatly, more bone having been taken away if necessary, it is pegged in place by means of a bone peg or nail. It is important that the tubercle of the tibia should be fixed sufficiently far down the bone to take up any slackness which may have been present in the patellar ligament.

The second part of the operation consists in the plication of the capsule on the inner side of the joint. The capsule is divided by a vertical incision, at least one inch from the inner border of the patella, and freed from the underlying fatty tissue. The two free edges are then picked up, one laid over the other so that the two edges overlap. When the patella lies comfortably between the two condyles of the

femur the capsule is re-sutured with the necessary overlap, care being taken that there is no slackness in the capsule. If the patella will not lie comfortably, a vertical incision is made through the capsule on the outer side of the patella so that the capsule will gape and the plication is carried out on the inner side as described. It is neither necessary to sew up the capsule on the outer side of the patella, nor to injure the synovial membrane during the procedure. The skin incision is closed and the limb is placed in a trough of plaster of Paris. When the stitches have been removed, the limb is still left in the plaster trough and faradism is employed for the quadriceps. Four weeks after the operation the patient is allowed to walk with a stiff knee, wearing a

plaster trough or ham-splint. Knee flexion is commenced eight weeks after the operation at a time when the splint is discarded.

(3) In the absence of genu valgum, the operation of transference of the tubercle of the tibia inwards with or without plication of the capsule is eminently satisfactory.

Criticism of Operation. In recent years considerable attention has been given to the treatment of this condition; consequently a number of operations have been described to prevent the habitual dislocation. Albee advised reconstruction of the external condyle of the femur. This condyle is usually flattened, and he elevated the anterior surface by osteotomy and filled in the gap by a bone graft. Robert Jones and Goldthwait split the infra-patellar tendon, and after dividing the lateral half from the tibial tubercle, fixed it to the inner side of the tibia after passing it behind the other half of the patellar ligament; alternately half the tubercle of the tibia was transplanted inward; latterly Jones transplanted the whole of the tibial tubercle as has been described, and he advocated Albee's operation in a few cases when the external condyle was very much flattened. Both these authors agree on the importance of correcting the knock knee first. Tubby advocated plication of the capsule only, but as this measure was found to be insufficient Whitelocke suggested the transplantation of a portion of the semimembranosus or gracilis muscle into the inner side of the patellar ligament.

INJURY TO THE TUBERCLE OF THE TIBIA

(1) The tubercle is seldom torn off from the tibia. The symptoms and signs are similar to those of rupture of the lower end of the ligamentum patellæ, and the treatment is described in Chapter VI.

(2) Partial separation is frequently termed Osgood's or Schlatter's disease. The condition is more common in boys than in girls, usually between the ages of eight and fourteen. It may be uni- or bi-lateral. The condition may belong to the group of diseases called osteochondritis, or may be the result of injury. In the former group, trauma probably plays a part, and there is a divergence of opinion as to whether focal infection is a factor in the ætiology.

Symptoms and Signs. It is necessary to divide the cases into two groups because the symptomatology varies to a great extent.

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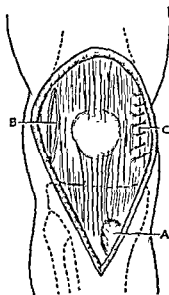


Fig 1924.—DIAGRAM OF KNEE JOINT TO INDICATE OPERATION USED IN SEVERE CASES OF SLIPPING PATELLA

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- B. Incision on lateral side of the knee joint capsule.
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Symptoms and Signs. It is necessary to divide the cases into two groups because the symptomatology varies to a great extent.

Group I. There is a gradual onset of pain at the upper end of the tibia, often in both knees, but there is no history of injury.

Examination shows the tubercle of the tibia to be tender, and it may be swollen.

Group II. There is a history of injury, local swelling and pain, and there is often thickening around the tubercle and over the lower half of the joint. Pain may be present on full extension of the knee.

Radiology. In the early stage there may be slight separation from the tibia of the tongue-like process of the epiphysis ; later, the process



Fig 1925.—X-RAY SHOWING SCHLÄTTER'S DISEASE OF THE LEFT TIBIA.

may appear to be tilted somewhat and stand away further. The deep surface of it may be fluffy and a similar appearance be present on the adjacent surface of the shaft. At this or a later stage, the tongue-like process may become fragmented. During the healing process there is an increase in density of all the bone affected, and fusion of this portion of the epiphysis may occur earlier than normal.

Treatment. The object of treatment is to prevent the pull of the patellar ligament, so that it is necessary to stop contraction of the quadriceps by keeping the knee straight. This is carried out by the patient wearing a ham-splint or posterior plaster splint, arranged so that there is no irritation by bandages or straps over the affected area. Local treatment by counter-irritation, pressure, or operation is not

required. Pain will usually disappear in two weeks, but the splint is kept on for at least three months. After that time the patient should not be allowed to play games for another period of three months. If pain should return when the splint is removed, it must be reapplied. The X-ray changes indicative of the condition being healed may extend to over twelve months, but it is not usually necessary to limit the patient's activity for this period. It seems that the course of the condition is not materially affected by the splinting, but pain and swelling are prevented.

BURSITIS

Of the many bursæ round the knee, only two give rise to frequent trouble.

(1) *Pre-patellar Bursa.* This is liable to acute and chronic inflammation producing what is popularly termed "housemaid's knee."

Anatomy. This bursa is situated in the subcutaneous tissue in front of the knee. It overlies the distal two-thirds or whole of the patella and the upper half or so of the *ligamentum patellæ*. In breadth it is normally a little over one inch. In the normal knee the bursa has a thin wall and a very small quantity of fluid within it. It is not palpable, but under pathological conditions it may enlarge to the size of half a tennis ball.

The bursa is particularly liable to injury from kneeling. The frequent friction occurring to the knee in this posture may cause thickening of the wall of the bursa and effusion into it. Such a condition produces a spherical swelling in front of the knee. It feels firm, but may be fluctuant. It may produce no discomfort until a particular injury causes hæmorrhage into it or distension with fluid. When this has occurred, the bursa is tender, kneeling painful, and pain is produced by flexion of the knee. There is no excess of fluid in the knee joint.

Treatment. Such a condition will recover if kneeling is stopped, movement of the joint limited, and counter-irritation employed. The bursa will then settle down by absorption of some of the fluid, but the walls will remain thickened as they were before the acute attack. The acute symptoms frequently recur, however, when the friction of kneeling irritates the bursa again or it receives a definite injury. Frequent hæmorrhages into the bursa may be the cause of fibrinous

Group I. There is a gradual onset of pain at the upper end of the tibia, often in both knees, but there is no history of injury.

Examination shows the tubercle of the tibia to be tender, and it may be swollen.

Group II. There is a history of injury, local swelling and pain, and there is often thickening around the tubercle and over the lower half of the joint. Pain may be present on full extension of the knee.

Radiology. In the early stage there may be slight separation from the tibia of the tongue-like process of the epiphysis; later, the process



Fig. 1925.—X RAY SHOWING SCHLATZER'S DISEASE OF THE LEFT TIBIA.

may appear to be tilted somewhat and stand away further. The deep surface of it may be fluffy and a similar appearance be present on the adjacent surface of the shaft. At this or a later stage, the tongue-like process may become fragmented. During the healing process there is an increase in density of all the bone affected, and fusion of this portion of the epiphysis may occur earlier than normal.

Treatment. The object of treatment is to prevent the patellar ligament, so that it is necessary to stop the quadriceps by keeping the knee straight. This is carried out by the patient wearing a ham-splint or posterior plaster splint, that there is no irritation by bandages or straps over the knee. Local treatment by counter-irritation, pressure, or

required. Pain will usually disappear in two weeks, but the splint is kept on for at least three months. After that time the patient should not be allowed to play games for another period of three months. If pain should return when the splint is removed, it must be reapplied. The X-ray changes indicative of the condition being healed may extend to over twelve months, but it is not usually necessary to limit the patient's activity for this period. It seems that the course of the condition is not materially affected by the splinting, but pain and swelling are prevented.

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bodies, either loose or attached to the lining membrane of the bursa.

The *treatment* of chronic bursitis consists in removal of the bursa. The incision for this operation should be planned so that the scar does not occur over the area on which the patient will subsequently kneel.

Acute bursitis occurs usually in bursæ which are already affected by a chronic or recurrent sub-acute bursitis. The infection may reach the bursa by a penetrating wound, by organisms passing through the rough skin often overlying the bursa, or by the lymphatics. If there is infection round a toe, such as a suppurating corn, this infection may travel up the lymphatics and infect a chronic bursitis so as to produce an acute inflammation of the bursa. The *treatment* of acute bursitis consists in fomentations, and incision if necessary.

(2) *Popliteal Bursitis*. This name is given with some hesitancy in order to avoid the term "semimembranosus bursitis." There is normally a protrusion of synovial membrane around the tendon of the semimembranosus muscle on the back of the knee joint. The communication is in some cases small, and in some cases large. When there is a large communication with the joint, a fluctuant swelling is present on the inner side of the popliteal space whenever the joint is distended, whether with synovial effusion or tuberculous material; consequently such a swelling is found associated with many conditions of the knee joint, particularly osteo-arthritis associated with effusion and, at times, with tuberculosis of the knee joint.

In children and young adults it is not uncommon to find a fluctuant swelling in the popliteal space on the inner side when no other symptoms or signs are present in the knee. The condition is often termed "semimembranosus bursitis." However, as a rule the condition is a ganglionic swelling containing jelly. It is situated around the tendon of the semimembranosus, but the ganglion has no direct communication with the joint. Its removal is not advised unless it is causing symptoms or is increasing rapidly in size. If operative treatment is carried out, it is generally found that the ganglion is multilocular and that the joint is opened before the ganglion is completely removed. This is due to the fact that the ganglion is attached to the semimembranosus tendon or to the capsule at the back of the joint and it is necessary to remove a small portion of the capsule in order to remove the ganglion completely.

Other bursæ around the knee seldom give rise to trouble. There is a bursa between the tibia and ligamentum patellæ which is termed the

pre-tibial bursa. It has no communication with the knee joint, but may become inflamed. Such a condition is recognised by tenderness over the patellar tendon and apparent enlargement of the tubercle of the tibia. The knee may be painful when the patient extends it. If the joint is put at rest, the condition will subside.

CHAPTER III

ACUTE OSTEOMYELITIS

THIS condition is considered an uncommon disease at the present time. That it is serious is shown by the fact that in England and Wales over four hundred patients die per annum from osteomyelitis, whereas about seven times that number of deaths occur per annum from acute appendicitis.

Ætiology. The condition is twice as common in the male sex as in the female. The highest mortality occurs between the ages of ten and fifteen. There is frequently a history of an injury to the affected limb and sometimes a primary focus of infection can be recorded; such a primary focus may be in the skin or in the lungs or elsewhere in the body. The staphylococcus aureus predominates as an infecting organism, the staph. albus is rarely found, while streptococcus occurs in a number of cases and pneumococcus at times. Organisms of the coli group, particularly the B. typhosus and B. paratyphosus, cause sub-acute osteomyelitis. Tuberculous osteomyelitis and osteomyelitis associated with open wounds are not considered in this chapter.

Bones affected. The bones affected most frequently are the femur and the tibia, but any bone in the body may be primarily or secondarily involved.

Morbid Anatomy. The primary deposit in the bone may be situated:

(1) In the metaphysis, that is on the diaphysial side of the disc of cartilage separating the shaft, i.e. the diaphysis, from the epiphysis.

(2) Under the periosteum near the end of the bone or elsewhere along the shaft.

(3) In children the infection may commence directly in the epiphysis.

(4) The medulla may be affected in any region of the shaft in the adult.

Progress of the disease. During the critical age period for this disease, the metaphysis is most frequently affected owing to the arrangement of the blood supply in this area and possibly owing to the greater liability to injury.

There is a deposit of organisms which rapidly increases, forming a small abscess. The spread occurs early and rapidly to the subperiosteal space as is shown in the diagram, and there is little tendency for spread along the medullary canal in the early stages. As soon as there is pus in the subperiosteal space, the periosteum tends to strip up so that an abscess forms between the periosteum and the compact tissue. This abscess may spread round the bone, even stripping up the periosteum of the whole of the shaft. Such a state of affairs may exist although the focus is still small in the cancellous tissue. At a later stage the medulla may be infected by retrograde infection along the Haversian canals, or from spread from the focus in the metaphysis.

The infection may spread into the neighbouring joint, producing suppurative arthritis by penetrating the cartilage separating the epiphysis and diaphysis and then entering the joint directly through the epiphysis, or secondly a subperiosteal abscess may spread through the soft tissues and capsule and so infect the joint.

When the primary focus is situated in the middle of the shaft, spread occurs along the medullary cavity towards the ends of the bone.

The structure of bone differs from that of soft tissues to such an extent that the reaction of bone to infection is necessarily different from that of soft tissues. Thrombosis of blood-vessels of bone may result in necrosis of portions of the bone, or even endanger the nutrition of the whole of the shaft, a matter of the greatest importance in planning operative procedure. Devascularised bone usually becomes a sequestrum, and rarely is reintegrated in the shaft.

The spread of the condition in the *adult bone* differs from that in the *child* owing to the absence of an epiphysis and the greater resistance



Fig. 1926.—DIAGRAM TO SHOW THE POSSIBLE SITES OF ORIGIN AND SPREAD OF OSTEOMYELITIS.

1. At the end of the diaphysis. Spread may occur through the cancellous and compact tissue to the subperiosteal space. Spread to the joint may occur directly through the epiphysis or by spreading from the subperiosteal space into the surrounding tissues or through the capsule of the joint.
2. Origin in the subperiosteal space at the metaphysis.
3. Origin in the centre of the epiphysis
4. Origin in the centre of the diaphysis. In adults the origin may be in the subperiosteal space at any point along the diaphysis.

offered by the periosteum. Spread may occur in the medulla or under the periosteum, but spread is seldom rapid as in the cases of children. In the adult, when pus is under the periosteum, there is a greater tendency for the condition to increase very slowly; moreover, the tendency is for such an abscess to break through the periosteum into planes between muscles rather than to spread round the shaft under the periosteum.

Symptoms and Signs. Cases of acute osteomyelitis commence in a variety of ways so that the diagnosis is often very difficult in the early stages. Two clinical groups are definitely recognised:

(1) In this group, there is a *sudden onset* of general and local signs, when the patient, usually a child, has been seedy for a day or two. This type of onset is most frequent in the infections due to streptococcus. There may be rigors, and the temperature is raised to 104° or more, and pulse-rate to over 120.

(2) A varying degree of severity may produce *symptoms lasting a week or more*; during this time the general symptoms may be more severe than any signs in the affected limb. It is during this stage that every effort should be made to establish a diagnosis. The so-called *prodromal phase* should not have a place in the symptomatology, for the general condition of the patient should be significant of a general infection, and *persistent pain at the end of a long bone* associated with *tenderness in the region of the metaphysis* is sufficient to indicate that infection is present in the bone. This condition is almost invariably associated with a limp or weakness of the limb, although such symptoms may be intermittent and are obviously more difficult to determine in a child under ten than in one who is older.

If the disease is not recognised in this early stage, *the general condition* will become increasingly serious in the severe type of osteomyelitis, and the temperature will not become normal in the milder type. At the same time pain will increase at the site of the disease, and examination will show swelling at the end of the bone associated with tenderness and usually an effusion into the neighbouring joint. If the diagnosis is still further delayed, the skin will become hot, tender and cedematous. The existence of pus under the periosteum or in muscle planes will be recognisable by fluctuation in certain parts of the body.

Complications. When the septicæmia and pyæmia are very severe in an untreated case, or in a case not reacting to treatment, serious

complications may occur. Endocarditis, myocarditis, pyelonephritis and empyema may be seen in children and adults and are usually fatal.

A number of cases develop sub-acute osteomyelitis in a large number of bones. Although these appear serious during the early stages of the disease, the patients usually recover if the infection is limited to bones. Acute suppurative arthritis in the neighbouring joint, or in one or more joints elsewhere in the body, is not uncommon.

Differential Diagnosis.

(1) In the early stage, when the *general condition* of the patient occupies the attention of the doctor, the child may be too ill with toxæmia, septicæmia or pyæmia to make it possible to recognise a primary lesion of the bone, such as osteomyelitis of the upper end of the femur.

(2) A diagnosis from *affection of a joint* may lead to difficulties. In this connection it is essential to exclude rheumatic fever, in which the pain tends to shift from one joint to another. Although osteomyelitis most frequently affects one bone only, many bones may be affected, and in this type of case the diagnosis from rheumatic fever is difficult. The child is more ill in the early stage of osteomyelitis affecting many bones than he is in the early stage of rheumatic fever, and sweating is more profuse in rheumatic fever.

The diagnosis of osteomyelitis from suppurative arthritis may be impossible in situations such as the hip joint. In the majority of cases the arthritic condition is secondary to osteomyelitis, so that provided it is recognised that the infection is in the bone or joint, or both, immediate attention will be centred on the treatment.

(3) Suppuration in muscle and subcutaneous tissue may be confused. More often the diagnosis of cellulitis is made in error in the presence of osteomyelitis than the reverse. This is exemplified by incision of the area thought to be affected with cellulitis, but exploration of the infected area shows that the underlying bone is affected with osteomyelitis.

Less often an error in diagnosis is made in cases of subperiosteal fractures, erythema nodosum and hæmorrhage under the periosteum such as may occur in scurvy.

The diagnosis of osteomyelitis of bones such as the pelvis and frontal bones presents other difficulties, as do also cases of sub-acute osteomyelitis in the adult. Sub-acute osteomyelitis of the femur and tibia present symptoms and signs of other chronic bone affections, particularly sarcoma.

ANCILLARY METHODS OF EXAMINATION

(1) *Pathological.*

(a) *Leucocytosis.* The fulminating and severe types of osteomyelitis are associated with a leucocytosis of 20,000 and more, with a total and relative increase of polymorphonuclear leucocytes. The majority of cases of this type are recognised clinically so that this examination is only confirmatory. The sub-acute and less severe type of disease is frequently associated with a leucocytosis of between 10,000 and 15,000. Such a blood examination is seldom sufficient to clinch the diagnosis.

(b) *Blood culture.* Although the condition is due to septicaemia the staphylococcus is seldom recovered from the blood. The streptococcus is usually recovered from the blood in those cases in which the diagnosis is clear, and the existence of the organism in the blood is an indication of the severity of the patient's condition.

(c) *Examination of a portion of the bone removed* serves a useful purpose in two types of cases.

(i) In early cases when operation has been performed on the metaphysis, the surgeon may be in doubt as to whether he has found the focus of disease in the cancellous tissue or even whether an early osteomyelitis is present. This is particularly the case in the os calcis and upper end of the humerus. The culture of tissue removed and the

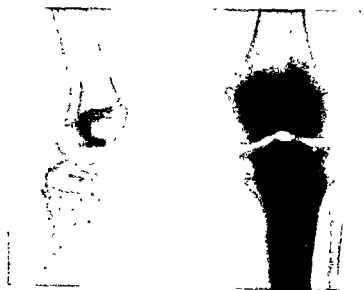


Fig. 1027.—X-RAY SHOWING OSTEOMYELITIS OF THE METAPHYSIS AT THE UPPER END OF THE TIBIA.

growth of an organism is a confirmation that the affected area has been found.

(ii) In the adult cases where difficulty in the diagnosis exists between osteomyelitis and a growth such as sarcoma, examination of the bone bacteriologically and by section will be of considerable value.

(2) Radiological.

In the early stage of osteomyelitis the X-ray is normal. In a sub-acute case ten days or a fortnight may pass before new bone formation occurs under the periosteum parallel to the long axis of the bone; irregular rarefaction may be seen in the cancellous tissue. In the acute cases it is seldom that X-ray changes are ever recognised.

A skiagram will help to exclude subperiosteal fractures and cases of scurvy.

In adults the differential diagnosis between sub-acute osteomyelitis and endosteal sarcoma of bone may be aided by an X-ray, but at times the X-ray picture is such that it is impossible to be dogmatic about the diagnosis, even taking the clinical signs and skiagram together. In each there may be new bone formation parallel to the long axis of the bone with rarefaction underneath. In osteomyelitis the subperiosteal new bone seldom has a break in it and the rarefaction is usually directly within it. In the sarcoma the new bone formation tends to be above and below the growth so that there is often an area in the centre without new bone formation, and the rarefied bone is patchy and more extensive than that seen in osteomyelitis. The X-ray appearance of osteogenetic sarcoma should not be confused with osteomyelitis, for the striæ of bone are at right angles to the long axis of the shaft of the bone.

Operative aids to diagnosis by incision and aspiration are considered under treatment.



Fig. 1928.—LOCALISED OSTEOMYELITIS OF THE UPPER HALF OF THE FEMUR IN AN ADULT. SEQUESTRA CAN BE SEEN.

Treatment. The *general infection* (septicæmia) must be treated by appropriate treatment as well as the operative treatment of the affected area. The value of purgation and the intake of a large quantity of fluid is recognised and should be carried out. Intravenous antiseptic medication is practised by a number of surgeons, but no reliance can be placed on its value, and the majority of surgeons doubt its efficacy; consequently, it is seldom used except in fulminating cases. It is considered that immuno-transfusion is probably of more value in these cases, although experience is still limited in this form of treatment.

Local Treatment. Three clinical types will be considered:

(1) Osteomyelitis of the end of a long bone when there is clearly no complication beyond that of the general condition.

(2) Osteomyelitis of a long bone when there is suspected or recognised suppurative arthritis of the neighbouring joint (see page 3412).

(3) When either (1) or (2) exist and there is also osteomyelitis of another bone or arthritis of a joint elsewhere (see page 3416).

(1) *Osteomyelitis at the End of a Long Bone* (metaphysis).

The object of the operation is to open the abscess of the bone, and to do this in such a way that subsequent necrosis of the bone is avoided or limited to the minimum extent. It is desirable that the operative procedure should be such that the after-treatment does not necessitate frequent painful dressings. A considerable number of types of operation have been devised and are still carried out, probably because no one type of operation can be claimed by its most ardent supporter to avoid subsequent necrosis in 100 per cent of cases and to have no mortality associated with its performance. It is probable that the operator accustomed to one type of operation produces better results than a surgeon whose services are seldom called on to carry out this operation, even if the latter performs what is recognised as the most satisfactory procedure.

It is considered that *incision of the periosteum* alone and the opening of the metaphysis by drill-holes are procedures which are followed by necrosis; therefore, these should not be employed. The plea that such procedures may save the life of a patient who is very ill is hardly justifiable, as the length of time taken to open the medulla by removing the compact bone with a gouge is negligible provided the correct instruments are available. The operations of choice are:

- (a) Metaphysial drainage.
- (b) Diaphysial drainage.

Either of these may be completed by the vaseline pack and plaster of Paris casing (Winnett Orr).

- (c) Subperiosteal resection of the diaphysis.

Whichever method is used it is considered that whether the plaster of Paris is used or not, efficient splinting should be employed so that the limb is kept at rest, and so that the wound can be dressed without movement of the limb or disturbance of the splinting (see fig. 1944).

(a) *Metaphysial Drainage.* With careful planning and the use of correct instruments this operation can be done expeditiously and is followed by necrosis in only a small number of cases, provided that the operative procedure is carried out at an early stage of the disease and that it is not too extensive.

A tourniquet is employed whenever the site of the operation allows it; obviously this is impossible for operations on the upper end of the femur, humerus, clavicle, etc. The limb is placed on sand-bags. An incision is planned so that this avoids vessels and nerves and does not necessitate a section of muscles across their long axis. Whenever possible the ease of after-dressing may be taken into consideration. In osteomyelitis of the femur, incision is on the outer side of the limb;

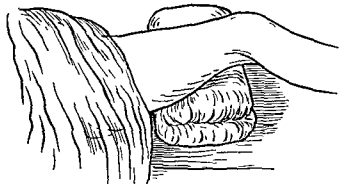


Fig. 1929.—POSITION OF LOWER LIMB OF SLIGHT FLEXION AND INTERNAL ROTATION WITH THE THIGH RESTING ON A SAND BAG, SUCH AS IS USED FOR OPERATION ON THE FEMUR WHEN IT IS APPROACHED FROM THE OUTER SIDE.

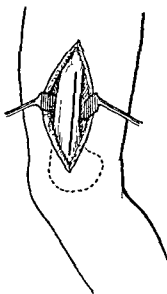


Fig. 1930.—LINE OF INCISION OF THE PERIOSTEUM OF THE LOWER END OF THE FEMUR.

for the tibia it is usually along the inner side of the limb along the posterior border of the tibia. Exposure of the upper end of the humerus is carried out through the deltoid muscle. On these lines it is not difficult to decide the line of the incision, but when an abscess is pointing, the bone is approached through this abscess. Consequently many operations on the lower end of the femur have to be carried out from the inner side. The greatest difficulty with the incision that the author has experienced has been in the rare cases of osteomyelitis in the upper half of the radius. In a case of this type, it is wise to expose the posterior interosseous nerve and have it retracted while the operation is carried out on the bone.

The operative procedure can be modelled on the "type operation" employed for osteomyelitis of the lower end of the femur.

After the application of the tourniquet the limb is rotated slightly inward, with the knee slightly flexed, and made to rest comfortably on

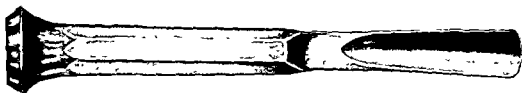


FIG. 1931.—THE GOUGE COMMONLY USED FOR OPERATION IN CASES OF OSTEOMYELITIS.

two sand-bags. Incision is made in the line of the bone from the junction of the diaphysis and epiphysis on the outer side upward.

The skin is retracted and the aponeurosis and vastus externus are incised down to the bone. The vessels which can be seen in the muscle are clipped, the muscle is retracted, and the periosteum and bone inspected. The periosteum is incised, as is shown in figure 1930. If pus is present outside the bone, some of this is collected for bacteriological examination. The extent of stripping up of the periosteum is noted and the pus is expressed from the subperiosteal abscess if such be present. A periosteal elevator is placed between the periosteum and bone so that the bone can be seen easily. A sharp gouge with a cutting edge $\frac{5}{8}$ inch long is then applied on the postero-lateral surface of the bone. In a boy of fifteen the primary bone incision will be placed $1\frac{1}{2}$ inches from the epiphysis, and correspondingly closer in a small child. The compact tissue is removed so that a window exists $1\frac{1}{2}$ inches long and about $\frac{3}{4}$ inch wide (fig. 1932). In most cases it is possible to recognise the infected area of the cancellous tissue and in some cases pus can be seen. Material is taken for culture purposes if there was no pus outside the bone. In the early

cases when the area of infection is small this opening may be sufficient, but it is usually necessary to enlarge this and to remove cancellous bone, amongst which infection is present. The compact tissue should always be removed when this is done to such an extent that the opening to the bone is not a cavity but rather a depression of saucer shape. Consequently, if it is necessary to expose the greater part of the medulla at the lower end of the femur, the popliteal surface and the outer surface of the femur should be removed.

At one time it was thought that less necrosis followed removal of four-fifths of the circumference of the bone in this type of operation,

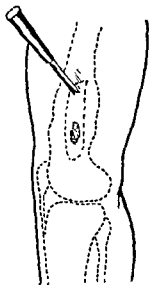


Fig. 1932.—DIAGRAM INDICATING OSTEOMYELITIS AT THE LOWER END OF THE FEMUR. THE AREA OF BONE TO BE REMOVED TO INVESTIGATE THE CONDITION IS MARKED OUT.

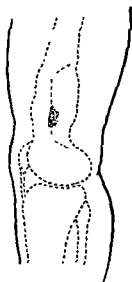


Fig. 1933.—DIAGRAM TO INDICATE THE AMOUNT OF BONE WHICH IS REMOVED WHEN MEDULLARY INFECTION EXISTS, i.e. THE POPLITEAL SURFACE OF THE BONE IS RESECTED.

but this is probably unnecessary. The resection of bone up the shaft should not necessarily extend the whole distance over which there was periosteal stripping; this procedure should be condemned partly because the extent of the subperiosteal abscess has no relationship to the size of the infection of the medullary cavity and partly because extensive opening of the bone (at any rate as a primary procedure) is usually followed by necrosis and formation of sequestra.

When the affected area has been fully exposed, surgical spirit is poured into the wound. This is absorbed by a piece of gauze placed into the wound. The wound is then filled up with flavine 1 in 1000 and again dried. A few large gauze swabs are then thoroughly saturated with flavine-paraffin-vaseline and packed firmly into the wound so

that the end of each piece of gauze protrudes out through the wound. The ends of these and the outside of the wound are then covered with one piece of gauze wrung out in the same emulsion, and this is covered with a quantity of gauze and wool and bandaged firmly on.

An elastoplast or adhesive strapping extension is then placed on the leg. The tourniquet is then removed and the limb placed on a Thomas's splint slightly flexed at the knee. Slings are applied under the thigh and calf and the extension fixed to the end of the splint. The Thomas's splint is adjusted in the bed to a Balkan beam or similar suspension apparatus.

After-Treatment. Should the dressing come through, further wool and bandage are applied, but the original dressing is not moved. On the seventh day the patient is anaesthetised with gas and oxygen, the packing is removed, and similar packing soaked in flavine-paraffin is placed in the cavity. The second dressing is carried out in another week when no anaesthetic is required. Subsequent dressings are carried out at five to eight-day intervals. It is usually wise to replace the flavine by saline every third or fourth dressing. The length of time taken for such a wound to heal may be as short a time as six weeks for a mild case in a small child to three or four months in a case of a larger bone. If the wound is not healing satisfactorily at the end of three months, an X-ray photograph is taken to see if sequestration has occurred. The treatment of this undesirable complication is considered subsequently.

Before describing the vaseline pack plaster of Paris method of after-treatment, it is desirable to consider :

(b) *Diaphysial Drainage.* The operation employed for diaphysial drainage is usually called the "gutter operation." It consists in the removal of compact tissue of half or more of the circumference of the bone over the infected area. Infected cancellous bone is removed at the same time. The indications for this operation are :

- (i) Osteomyelitis commencing in the centre of the medulla.
- (ii) Infection of the metaphysis which has been neglected and has spread down the shaft.
- (iii) Cases of chronic osteomyelitis.

The operation is completed by flavine-paraffin pack and efficient splinting or by Winnett Orr method.

The operation is founded on the theory that efficient drainage is

provided after removal of all the infected area. As the periosteum is allowed to remain intact, new bone forms readily and a strut of bone exists to keep the length of bone. Soon after its introduction, it was thought that necrosis occurred less after this operation than after others, and it certainly established efficient drainage. Unfortunately, injury to blood-vessels must necessarily be extensive in the performance of the "gutter operation" unless the gutter is short in length. Injury to the blood-vessels produces further thrombosis in addition to that already produced by the osteomyelitis; consequently there is a considerable liability for necrosis of portions of the bone to occur, or even of the whole of the shaft; at the same time it is recognised that every bone operation establishing efficient drainage is liable to be followed by this sequela. It is probable that removal of four-fifths of the circumference of the bone is sometimes more satisfactory than a small "gutter operation" in that the small piece of bone remaining is reintegrated into new bone without sequestration, whereas a greater piece of bone deficient in blood supply will die.

When this operation is carried out on a subcutaneous area such as the upper third of the ulna or shaft of the tibia, a deeply adherent scar often remains.

It is considered that this operation should be limited to the type of case indicated above, and further necrosis will result in a proportion of such cases.

"Winnett Orr Method." This consists of:

- (i) Immediate adequate drainage, as has already been described.
- (ii) *Maintenance of the limb at rest by the application of plaster of Paris aided, if necessary, by skeletal fixation.*
- (iii) Open drainage by means of a sterile vaseline pack.
- (iv) Avoidance of all antiseptics. (N.B.—Winnett Orr states that he wipes out the bone cavity with 10 per cent tincture of iodine followed by 95 per cent alcohol, although he emphasises the absence of the use of antiseptics.)

When metaphysial or diaphysial drainage is carried out by the method already described, the Winnett Orr method can be employed instead of the flavine-paraffin-vaseline pack. This will consist in:

- (i) Packing the cavity with a sterile vaseline gauze pack with the wound held widely open. The pack is covered with a dry sterile pad and bandaged into place.
- (ii) The limb is put in its correct position for splinting.

(iii) Plaster of Paris cast is then applied without any windows.

(iv) No window is cut and no dressing is changed except on account of odour, and not even then unless the patient's general condition is unsatisfactory.

It is claimed that (1) the wound will heal, pushing out the pack; (2) complications do not occur; (3) frequent dressings are not required. Experience shows that a few cases treated by this method, particularly those in small bones when the infection is not severe, run an uninterrupted convalescence in a most satisfactory way. In the majority of cases the temperature falls after the operation, but after ten days it rises and the plaster becomes extremely offensive owing to collection of discharge within it. This occurs to such an extent that the patient cannot be kept in a ward with other patients and is even a trial to his neighbours on a balcony. It is probable that these cases do best if the limb is left alone even at this time, but owing to the discharge coming out above and below the plaster, and the saturation of the plaster, it is inevitable that a change of plaster and dressing is necessary. This will be a painful procedure without an anæsthetic, and few surgeons are prepared to put up the case a second time with a similar dressing and plaster.

The use of skeletal traction, when there is osteomyelitis in the limb, is considered in this country to be unnecessary and associated with the risk of a secondary osteomyelitis at the site of the pin or wire.

The principle of *rest, sufficient drainage, and packing* is established in the treatment of osteomyelitis, but it is considered that splinting and weekly dressings are followed by better results than the vaseline pack and plaster of Paris splinting. The former is less worry to the surgeon and causes little more distress and discomfort to the patient, and it is *definitely a safer procedure in the fulminating cases of streptococcal osteomyelitis than is the Winnett Orr method.*

(c) *Subperiosteal Resection of the Diaphysis.* This operation may consist in the removal of the *whole length* of the diaphysis so that in a long bone the epiphysis at each end remains joined by the sheath of periosteum only, or in the resection of a *portion of the diaphysis*, such as the lower four inches of the shaft of the femur above the lower femoral epiphysis. Technique of the operation is straightforward in that the shaft is exposed through a linear incision, the periosteum is split from end to end and the whole of the diaphysis is removed (*diaphysectomy*). Efficient splinting is carried out to retain the length of the limb. In

the case of partial resection the smaller procedure is carried out on the same lines.

The advantages of this operation for acute osteomyelitis are :

- (i) The subperiosteal space is drained in the most efficient way.
- (ii) Theoretically the possibility of sequestration is entirely avoided.
- (iii) Uniform reformation of the shaft will occur.

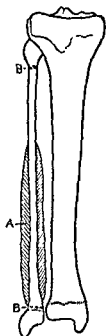


Fig. 1934.—COMPLETE DIAPHYSEAL RESECTION OF FIBULA. AN EXTENSIVE SUBPERIOSTEAL ABSCESS (A) OF THE FIBULA IS SHOWN, B...B SHOWS LINE OF SECTION IN COMPLETE RESECTION OF THE DIAPHYSIS.

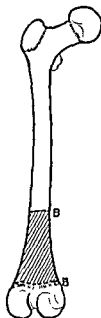


Fig. 1935.—PARTIAL DIAPHYSEAL RESECTION; AREA B...B RESECTED IN CASES OF LOCALISED OSTEO-MYELITIS OF THE LOWER END OF THE FEMUR.

The disadvantage of the operation is that regeneration of the shaft may not be complete owing to a portion of the periosteum being destroyed or injured.

This type of operation is probably suitable in the treatment of sub-acute osteomyelitis, but is unnecessarily radical in the acute metaphyseal infection in which simple drainage, as described above, is undoubtedly a satisfactory operation. Diaphysectomy is of value and indicated when the whole shaft is infected and the whole periosteal tube is separated from the bone, particularly in the fibula or a forearm bone.

In these cases it is not necessary to expose the whole length of the shaft as it can often be removed through a smaller incision, having already been separated from the epiphysis.

(2) *Osteomyelitis of a Long Bone* when there is suspected or recognised suppurative arthritis of a neighbouring joint.

This condition is relatively common when the osteomyelitis affects the upper or lower end of the femur or the upper end of the tibia. It is less common with osteomyelitis of the lower end of the tibia and the upper end of the humerus. It is infrequent in other parts of the body.

As a rule it is not the severity of the patient's illness which makes one suspect that a joint is affected, but either the physical signs show that the joint is distended or the joint is opened in the course of the operation (e.g. hip joint) when the operation is being carried out on the bone. A joint neighbouring on the site of an osteomyelitis should always be examined prior to operation, to determine if there is suspicion of its infection. Neglect to do so may necessitate an operative procedure on the joint a few days after the operation for osteomyelitis, which is obviously undesirable.

Two examples of treatment of this complication will be considered :

(a) A child presents all the signs and symptoms of acute osteomyelitis of the upper end of the tibia (temperature 104, pulse 130, limp, pain, tenderness over the upper end of the tibia, leucocyte count 23,000, 95 per cent polymorphs). The examination shows that the knee joint is distended so that the diagnosis is made of osteomyelitis of the upper end of the tibia with *fluid in the knee joint*. It is impossible to tell from the clinical examination if such fluid is reactionary and sterile, or purulent and therefore indicative of a suppurative arthritis secondary to the infection of the tibia.

The child is prepared for operation as for osteomyelitis. A needle of the size used for a lumbar puncture is fixed to a 20 cc. syringe. The needle is passed into the knee joint downwards and slightly backwards so that it enters the joint just above and to the outer side of the patella. Fluid is withdrawn until the joint is emptied. If it be clear or purulent, it is sent to a laboratory for investigation. The operation for osteomyelitis of the tibia is then carried out by the method already suggested. At the termination of the operation, the limb is splinted, the knee being flexed about 15 degrees.

If the fluid from the joint proves to be *sterile*, the case will proceed in a way such as is expected with infection of the tibia. The knee joint will probably distend again with fluid which will not absorb until

the tibia has greatly improved. Even if this distension occurs, there is no indication to aspirate the joint again unless the general condition indicates that some complication of osteomyelitis is present, and that there is no indication that a complication exists in another part of the body.

If the fluid from the knee joint proves to be *infected*, it must be appreciated immediately that the prognosis with regard to life and limb is much more serious. Those who favour immuno-transfusion undoubtedly find a greater success in its performance in this type of case as soon as it is realised that suppurative arthritis is present; however, management of the local treatment is undoubtedly of paramount importance. The difficulty does not lie in the performance of any operation, but in the decision as to when any procedure should be carried out. Although it is necessary to be drastic in the severe cases, every effort should be made to proceed with caution. Unnecessary or too early interference may lead to ankylosis of a joint or loss of limb; on the other hand, delay in draining a joint or in amputation of a limb may lead to loss of the patient's life.

On the day after the operation for osteomyelitis and aspiration of the joint, the temperature is likely to be between 100 and 104 and the joint again distended, even in the case of a mild infection. Unless the general condition is serious the joint should not be aspirated that day. In the milder cases, the joint will settle down and further aspiration will be quite unnecessary. More often a second aspiration is advisable on the third day, but fall of temperature may follow this, and in a number of cases in children a rise of temperature above 100 will not occur again. If the general condition is satisfactory but the joint continues to distend, two or three aspirations may be carried out at two or three days intervals, before resorting to arthrotomy.

If the general condition is serious from the outset, or showing no signs of improvement, and there is continued pain in the joint, and this fills up quickly after aspiration, arthrotomy, i.e. opening of the joint, is advisable. It is impossible to be dogmatic as to when exactly this should be done; the indication depends on the general as well as the local condition. It is usually necessary to perform the operation on adults at an earlier date than on children; too early performance of the operation may lead to a stiff or partly stiff joint, whereas undue delay may endanger the patient's life. The details of the operation are described on page 3431.

If the patient's condition shows no signs of improvement after drainage of the joint, the question will arise whether amputation is

advisable. This is necessary under two conditions. (i) If the general condition of the patient is declining and pus is pocketing all round the joint. (ii) If there is persistent high temperature, disorganisation of the joint, and bone affected with osteomyelitis to such an extent that a useful limb seems improbable, particularly if small pyæmic abscesses are forming.

(b) The general condition and signs indicate that there is an acute inflammatory condition of the hip joint or osteomyelitis of the upper end of the femur, or both. The temperature, pulse-rate and leucocyte count are indicative of an acute condition, so that it is considered that pus is present in one or both of these situations.

In the early stages of this condition it may be difficult to tell that the infection is deeply seated. When it is appreciated that the infection is in one of these two places, the physical signs seldom enable one to differentiate whether the infection is in the joint or bone. If there is an acute suppurative arthritis only, all movements of the hip joint are limited and painful, a condition which is also present when infection has spread into the hip joint from the femur. If the infection is in the femur alone, there may be a distension of the hip joint, with clear fluid. The spasm of muscles covering osteomyelitis of the upper end of the femur and a distended (although sterile) hip joint may produce limitation of movement of the hip in all directions.

Consequently, the condition of the joint cannot be determined until the nature of the fluid in it is known. It is more difficult to withdraw this fluid than in the case of the knee joint already quoted.

The patient should be anæsthetised and an attempt made at aspiration of the hip joint by inserting a large-bore needle into the anterior part of the hip joint. The needle is introduced from outside the joint below the anterior superior iliac spine, between sartorius and tensor fascia femoris; it is passed inwards, backwards and upwards. Two or three attempts may be made, but this is an extremely difficult and unsatisfactory procedure. If pus is withdrawn it is established that an arthritis is present, but there is no proof of the absence of osteomyelitis, and the indication is to proceed with the operation as for osteomyelitis. On the other hand, if no fluid is withdrawn this is frequently the result of failure to find the joint with the needle. Although the author employs an aspiration as a means of diagnosis of the condition of the hip joint, no reliance is placed on a negative finding. It is considered that in every case of osteomyelitis of the upper end of the femur when any doubt arises as to whether there is

any infection of the hip joint, the hip joint should be opened at the time of the operation.

The operation is performed as follows : An incision is made down the outer side of the thigh from above the great trochanter downwards, the femur exposed in its upper quarter, and the periosteum split along the outer side. If pus is found under the periosteum (which is rare in this region) it is mopped away. The femur is opened with a gouge just below the great trochanter, and the muscles retracted inwards so that the anterior surface of the femur is reached. If the infection in the medulla is spreading up the neck, this is opened in the front as much as possible. An incision is then made into the lowest part of the capsule of the hip joint in front and fluid will flow out into the wound. If this is purulent, it may be necessary to separate the muscles rather more, in order to enable a reasonable opening to be made. If clear fluid passes out, no further action is taken. The joint fluid is taken for bacteriological examination.

The bone operation is completed and the femur packed with flavine-paraffin. If pus is found in the joint, a drainage-tube is passed through the wound to reach the incision made into the capsule of the hip joint. The limb is then splinted on a Thomas's splint with a large ring, and extension applied to the leg.

It may be necessary to dress this wound in forty-eight hours under gas. The flavine-paraffin pack is not touched, but irrigation of the tube is carried out and the tube is twisted and shortened slightly. Further dressing in three days, probably also under gas, is necessary. If the patient's general condition is satisfactory, the drainage-tube can be dispensed with in ten days and the case is treated henceforward as a case of osteomyelitis only. If the suppurative arthritis continues active for two or three weeks, an X-ray examination is then made which may show osteomyelitis of the ilium or the changes of osteomyelitis associated with those already recognised in the femur. Secondary drainage of the hip joint may be necessary posteriorly or an incision may be necessary down to the ilium ; either of these procedures is delayed if possible.

The condition described is extremely rare in an adult, but not uncommon in a child owing to the anatomy of the epiphysis and owing to the fact that osteomyelitis in this region is rare in an adult.

It is extremely important to provide efficient immobilisation and extension, as *pathological dislocation* of the hip joint is a complication which will almost invariably occur in a child suffering from osteo-

myelitis of the femur and suppurative arthritis of the hip joint, if the limb is not adequately splinted.

The condition is serious at the outset, but responds to treatment if efficiently carried out, and sequestration is relatively uncommon in this situation. If there is a mild suppurative arthritis only, a child recovers with a considerable range of movement but not with a normal joint; in later life a secondary arthritis will develop. If the head of the femur is partly destroyed, fibrous or bony ankylosis may occur; if the growth area of the bone has been involved, there is shortening of the limb. Pathological dislocation will be associated with considerable shortening of the limb also.

(3) When *osteomyelitis or osteomyelitis complicated by suppurative arthritis is present*, and it is found that osteomyelitis of another bone or distension of a joint at another part of the body is present, the prognosis is serious. It is evident that the septicæmia is serious, and all sites of infection must be attacked at the primary operation if possible.

If there are two foci of osteomyelitis, the operation should be performed on each under the primary anæsthetic on lines already advised.

Case 1. Where there appears to be an osteomyelitis of the lower end of the right femur and distension of the left ankle joint, careful examination should be made of the left tibia to endeavour to elicit if this bone is tender. If it is not tender, the ankle joint is aspirated and splinted. Operation is performed on the right femur. If the left ankle continues to be distended and signs of osteomyelitis in the tibia appear two or three days after the primary operation on the femur, the tibia must then be opened.

Case 2. If at the time of the primary examination the tibia was tender, the ankle joint is aspirated and the tibia opened at the same time as the operation on the femur.

Unfortunately patients who have a second bone focus or arthritis away from the primary bone at the time of the onset of the disease frequently develop other complications either in bone, myocardium or kidneys. On the other hand, it is not uncommon to see boys and girls of about the age of twelve develop, about a week after the operation for osteomyelitis, sub-acute osteomyelitis of four or five bones; consequently, when the secondary bone abscess develops a week or more after the primary one, if the patient's general condition is not serious, it may be wise to delay the operative procedure on the second

bone affected for twenty-four or forty-eight hours. If this is done, two foci can be dealt with at once, and there is no reason to suppose that the delay has been the cause of the other foci, for they were produced by the general infection rather than by re-infection from one of the abscesses.

At times, when the patient appears to be recovering well from the primary osteomyelitis, infection of a low grade type will appear some weeks later in five or six bones at the same time. This is always

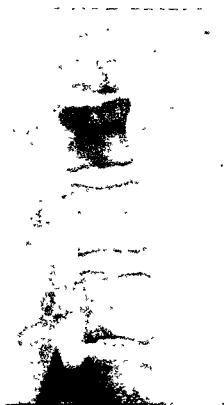


Fig. 1936.—LOCALIZED TYPHOID ABSCESSSES OF
VERTEBRÆ.

associated with a further rise of temperature, and the decision as to whether each focus should be opened as soon as it appears, or if operation should be postponed for a day or two, must depend on the patient's general condition.

When the primary operation for osteomyelitis is carried out, the operator always hopes that this will be the only manifestation of the septicæmia. When this is the case, the prognosis is not so serious except in the very acute hæmolytic streptococcal cases. Except in the latter type of case any type of operation will probably save the patient's life, but skilful operating and immobilisation of the limb will save the patient months of convalescence and secondary operations. The

dangers of septicæmia and the severity of complications add to the difficulties of many cases of osteomyelitis.

Typhoid Osteomyelitis. The inflammation of bone resulting from organisms of the bacillus coli group is most frequently seen as a complication of typhoid or paratyphoid fever. It may occur three or four weeks after the onset of the disease, but is more usually seen a year or more after recovery from the fever. The osteomyelitis usually attacks the tibia or ribs and the condition is sub-acute. Extensive necrosis of bone does not occur. An abscess between the periosteum and the bone is most commonly found. Such an abscess may contain a pure culture of bacillus typhosus or bacillus paratyphosus, or a mixed infection with pyogenic organisms may be present.

The patient may have slight malaise with aching pain in the bone. The skin may be tender and œdema may be present. Deep pressure may cause pain. X-ray examination shows erosion of the bone and some new bone formation at the edge of the abscess. There is a history of the fever and a Widal reaction is generally positive.

Treatment consists in incision of the abscess in the case of the tibia; in the case of a rib, if this is considerably eroded, a subperiosteal resection of the affected area of rib should be carried out. Further trouble does not arise at the site of the disease.

Osteomyelitis of the spine due to typhoid fever is very rare. It may affect the greater part of the spine, but seldom results in abscess formation.

CHRONIC PYOGENIC OSTEOMYELITIS

- (1) Diffuse or osteo-periostitis.
- (2) Resulting from acute osteomyelitis (see page 3421).
- (3) Brodie's abscess (see page 3424).

(1) *Diffuse, or osteo-periostitis*, is a sub-acute or chronic inflammation occurring in adults. It most commonly affects the larger limb bones, particularly the femur and humerus. There is a diffuse thickening of the bone involving its whole circumference. A portion or the whole length of shaft may be affected. The margin of the swelling invariably slopes gradually down to the normal bone.

The symptoms of this condition are: An aching rather than a pain in the limb, and periodic attacks of malaise may be present. During the activity of the inflammation there is tenderness on deep pressure, but at times this may be absent. The X-ray examination shows new

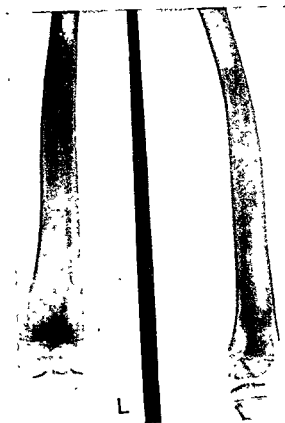


Fig. 1037.—CHRONIC OSTEOMYELITIS OF THE LOWER END OF THE FEMUR SHOWING AN ABSCESS CAVITY.

bone formation on the surface of the compact tissue which shelves down to the normal bone. There is often narrowing of the medullary cavity owing to thickening of the compact tissue on its deep surface. One or more areas of rarefaction may be present in the medullary cavity and tiny sequestra may be seen in such rarefied areas.

A subperiosteal abscess may occur and is usually sub-acute, but the condition may exist for a long time when it is associated with an abscess in the medulla. In this case a swelling on the bone may be fluctuant, but the edges of it are usually hard and it is unusual to find the whole circumference of the bone affected. The condition is seen more frequently as an acute than as a chronic osteomyelitis, and is referred to earlier in this chapter.

Differential Diagnosis. It is necessary to recognise this condition from localised swelling due to a united fracture, diffuse syphilitic periostitis, osteitis deformans, and sarcoma of bone. A subperiosteal abscess may be confused with a gumma or tuberculosis; it has been stated already that the condition may be either staphylococcal or due to typhoid. *Actinomycosis* may affect the jaw in a similar way.

The diagnosis of *fracture* should not be difficult owing to the history of injury and the X-ray appearance of the site of the fracture and callus formation. Certain rare cases of excessive formation of callus lead to the greatest difficulty, and a biopsy may be necessary to complete the diagnosis. Syphilitic periostitis is seldom limited to one bone. Nodes are likely to be present on other bones, and if the condition of diffuse periostitis has affected one half of the bone, there is often another area of the same bone affected. The Wassermann reaction will be positive and other signs of syphilis may be present. Osteitis deformans may affect one bone only and then usually affects the whole length of the bone, but thickening may be limited to a part of the shaft in the early stage of the disease. Pain, tenderness and œdema are often found. Curvature of the shaft of the bone may be seen in Paget's disease and syphilitic osteitis, but not in the case of chronic pyogenic osteomyelitis. The two former conditions are often recognisable by the loss of the crest of the tibia, for as the tibia becomes enlarged the bone tends to become rounded. In Paget's disease, if one bone only is affected it is usually the tibia, femur or ulna; sometimes three such bones are affected. In one type of the disease many bones are involved, usually in late middle age.

The diagnosis of osteomyelitis from *sarcoma* is particularly difficult in the femur and humerus. The increase in the size of the bone is more rapid in sarcoma and the patient becomes ill more quickly. The edge of the swelling is more sharply defined, but heat, tenderness and pain are similar in the two conditions. In this type of osteomyelitis the leucocyte count is usually raised, but seldom to any extent, and in sarcoma it is usually normal. The X-ray appearance of an osteogenic sarcoma is characteristic, in that the new bone formation is at right angles to the shaft of the bone, whereas in osteomyelitis the bone laid down is parallel to the shaft. However, in the destructive type of sarcoma in which there is destruction of the medulla and compact tissue, the appearance of rarefaction is not unlike that of some cases of osteomyelitis. Likewise new bone may be laid down in this type of sarcoma parallel to the shaft *at the edge* of the tumour. A certain diagnosis can only be made by biopsy. A piece of bone is removed, culture taken from this, and microscopic examination made of tissue which may be granulation tissue of osteomyelitis or sarcomatous material. In most cases a correct diagnosis will be established by this means, but the author has seen two cases in which the cultures were sterile, and the tissue removed was not characteristic of either condition, for it contained plasma cells in large quantities. Doubt was only

cleared up by the subsequent history of the two patients, the cases proving to be chronic osteomyelitis. It is probable that the microscopy of sarcomatous material will be definite, whereas doubt is likely to arise when the tissue is from a bone affected with chronic osteomyelitis.

Treatment. Operative treatment is indicated. The whole length of the area affected should be exposed and the "gutter operation" described above should be carried out and the limb immobilised at the time of operation. The wound will take a long time to granulate up, but if a short gutter only is made when eight inches of the bone are affected, further trouble will occur in that bone. The wound may heal by granulation or secondary suture may be employed. In the case in which a short gutter has been made, it is not uncommon to find that a "flare up" occurs some months or a year after the healing of the wound. This is only avoided by sufficient drainage in the first place. Experience shows that if one "flare up" occurs, this may be followed by others in the course of the next few years.

(2) *Chronic osteomyelitis resulting from acute osteomyelitis.* Stress has been laid on the importance of the primary operation for acute osteomyelitis because the changes occurring in the bone, which has been treated inefficiently, may affect the whole of the shaft and lead to necrosis of bone, not only during the months subsequent to the attack, but at varying periods of the patient's life. In the first case, this is shown by failure of the wound to heal, and in the second case by periodic formation of abscesses associated with separation of sequestra.

A case of osteomyelitis may be said to pass into a chronic stage if the sinus persists at the end of three months. The pathological changes present at the end of this period are :

(a) The formation of an *involucrum* (new bone formation under the periosteum).

(b) The separation of *sequestra* (dead portions of compact tissue). A sequestrum may consist of the whole of the diaphysis or one or more pieces of compact tissue.

(c) The persistence of sinuses through holes in the involucrum termed *cloacæ*. These persist while sequestra are present surrounded by granulation tissue and are indications of "foreign body tissue" in the limb. Such a sinus may periodically close up, but an abscess may subsequently form and burst through the old scar.

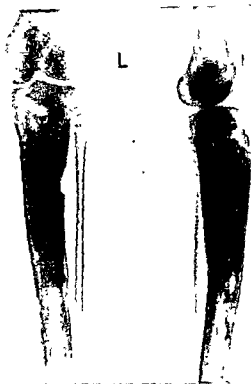


Fig. 1938.—OSTEOMYELITIS OF THE WHOLE LENGTH OF THE TIBIA, SHOWING INVOLUCRUM, CLOACAE AND SEQUESTRA. There had been an operation four months previously, when the periosteum had been incised.

If a probe is passed into a sinus, a sequestrum may be felt if it is near the surface or when a probe is passed (with considerable skill) into the cavity in which it is lying. Bleeding almost invariably occurs from the granulation tissue.

The X-ray examination is essential before deciding the correct treatment. The X-ray will show the extent of the involucrum and the situation of sequestra. It may be difficult to tell if the sequestra have separated. The interpretation of skiagrams of osteomyelitis is more difficult in the case of small bones such as those of the fingers than in the case of large limb bones. It is important to recognise if portions of the compact bone are being reintegrated into the new shaft.

Treatment. As soon as it is established that sequestra are loose, these should be removed. The principles of the operation are :

- (1) The approach to the bone should be through old sinuses.
- (2) The opening into the bone should expose all bone cavities.
- (3) All sequestra should be removed.



Fig. 1939.—OSTEOMYELITIS OF LOWER HALF OF FEMUR, SHOWING EXTENSIVE MEDULLARY INFECTION AND SEQUESTRATION.

This case had had a number of operations for removal of sequestra, but infection persisted.

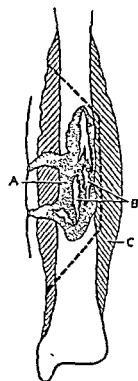


Fig. 1940.—DIAGRAM OF CHRONIC OSTEOMYELITIS OF THE TIBIA.

- A Granulation tissue in bone cavity.
- B. Sequestra.
- C. Involucrum.

The dotted line represents the area of bone removed for complete eradication of the affected area so as to make a U-shaped depression.

- (4) A plastic operation should be performed on the bone in such a way as to allow overlying tissues to fall in.
- (5) The above should be carried out by such means as will prevent further necrosis of bone. A tourniquet should be used whenever possible for the operation.

If several sinuses are present, the correct course to adopt is to expose the shaft of the bone on the ideal side of the bone, provided a sinus is present there; for instance, in the case of chronic osteomyelitis of the lower half of the femur, if a sinus is present on the inner

side and outer side, the sinus on the inner side should be neglected and the bone opened on the outer side. When the periosteum has been exposed this is incised round the cloaca and the incision is then carried up and down the bone and the periosteum is raised by an elevator. The bone is then removed with a gouge so as to expose the whole of the abscess in the centre of the shaft. The sequestra are removed; the cavity in the bone is then made into a pond-shaped depression. This can usually be done by removing two-thirds of the circumference of the shaft; the edges of the depression must be sloping, for it is necessary to allow the overlying tissues, particularly muscle, to fall into the cavity. When the pond-shaped depression has been made, the wound is filled with spirit which is then absorbed on gauze, before it is filled up with flavine; this is subsequently removed with gauze.

Two alternative courses now are possible :

- (a) Fixation of muscle into the cavity with closure of the wound.
- (b) Packing the wound with flavine-paraffin-vaseline.

The former is usually satisfactory when the abscess cavity has existed for some time and there is not extensive granulation tissue; the latter is advisable in children and in adults, when a "flare up" has recently occurred. Secondary suture may be possible when the packing is used or it may be wise to allow the tissues to granulate up.

When the subcutaneous surface of the bone has been opened, the pack is essential.

Immobilisation of the limb is essential after the operative procedure.

(3) *Brodie's Abscess*. A local sub-acute or chronic abscess may develop in a bone without a previous attack of acute osteomyelitis. The condition is due to an infection with the staphylococcus and may be secondary to staphylococcal infection of the skin or another part of the body. This condition differs from an abscess resulting from an acute attack of osteomyelitis, in that there has never been an acute inflammatory condition present. The infection in the bone has a tendency to periodic exacerbations.

It is most common in young adults and there is often a history of injury to the limb. The abscess is most commonly situated in the metaphysis of the head of the tibia or lower end of the femur. The lower ends of the tibia and radius and the upper end of the humerus are less frequent sites. Examination of a bone affected shows a condition varying with the length of time the abscess has been present and with the stage during which the bone is examined. There is inflammation of

the periosteum so that new bone is formed beneath it, usually on one side, but sometimes all around the bone. The abscess cavity may contain pus from which the staphylococcus can be obtained or the pus may be sterile; during the quiescent stage, the abscess cavity contains granulation tissue or even serum and may have a fibrous wall. Necrosis of bone is rarely seen. Occasionally the pus spreads through the compact tissue under the periosteum, and if it bursts through this an abscess is formed outside the bone.

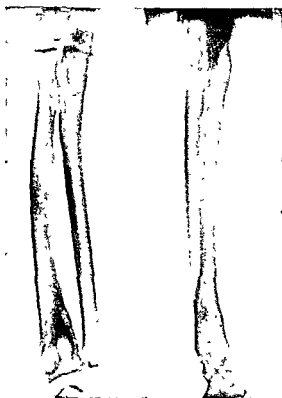


Fig. 1941.—Two BRODIE'S ABSCESSES SHOWN AT LOWER END OF THE RADIUS.

Symptoms and Signs. The general condition of the patient may be affected by periodic attacks of general malaise.

The usual complaint is one of a dull ache in the limb which is worse at night and usually intermittent. There is usually œdema of the skin and tenderness on pressure; enlargement of the circumference of the bone may be present around the abscess; the skin is seldom inflamed unless pus has reached the periosteum. These signs may disappear with rest and recur at intervals. An effusion into the neighbouring joint is frequently present.

The X-ray examination is characteristic. There is a central area of rarefaction in the bone with new bone formation under the periosteum

around the abscess and spreading up and down the shaft. If the condition has been present for some months considerable sclerosis of the bone around the abscess may be present.

The differential diagnosis in the early stages may be difficult. When the aching pains begin, physical signs may be negligible, and the condition may be confused with rheumatic pains or considered to be the result of an injury. Later, when changes are present in the X-ray, it is necessary to determine if the condition is due to a staphylococcal abscess, tuberculosis, or sarcoma. A white blood count may be of assistance, but often it is only possible to separate tubercle from the pyogenic infection by examination of the contents of the abscess. Central sarcoma can usually be diagnosed from the skiagram, but a biopsy may be necessary.

Treatment. It should be appreciated that this condition differs from a chronic abscess following acute osteomyelitis, in that sequestra are not formed. There are two popular methods of treatment :

- (a) drilling holes into the abscess cavity, or
- (b) exposure of the cavity and its obliteration.

The advantage of the first method is that the operation is small, and it relieves symptoms, but as the cavity is not obliterated necrosis of bone is liable to occur around its wall and further operative treatment is usually necessary. Although the second method necessitates a large operation (and there may be a much longer convalescence) it cures the condition ; consequently, this second method is advocated.

Operation for chronic abscess at the lower end of the femur. A tourniquet is applied. A vertical incision is made on the outer side of the femur down to the bone, the periosteum is incised, the femur is opened with a gouge and the abscess exposed. This is completely removed and the bone levelled off above and below so that a saucer-shaped depression remains. The wound is washed out with alcohol and then with flavine. Muscle is stitched into the cavity, or if this does not appear to fill up the cavity, a flap may be turned down from the muscle which will fit into the cavity. The wound is closed and the limb splinted for a month.

Operation for chronic abscess at the lower end of the tibia. A tourniquet is applied. A flap of skin is turned up over the subcutaneous surface of the tibia. The base of the flap is in front of the leg and the

convexity of the incision will be behind the posterior surface of the tibia. The bone is opened and the abscess can be dealt with in a similar manner to that described for the same condition in the femur. The skin flap is then sutured back so that it will fall into the bone. A small drainage-tube is inserted to prevent the formation of a hæmatoma. A pack of gauze is rolled up and placed on the flap of skin to press the skin into the bone cavity before the wool and bandage are applied. The limb is splinted. The drainage-tube is removed in forty-eight hours. The patient is not allowed to walk on the limb for six weeks.

It is not necessary in this case to use a flavine pack and to allow the wound to granulate up, as union by first intention is usual if the cavity has been dealt with thoroughly at the time of the operation.

If the operation for chronic bone abscess necessitates the removal of a considerable area of the metaphysis before the epiphysis has joined the shaft, irregularity of bone growth will occur.

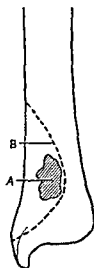


Fig 1942.—Diagram of Lower End of Tibia showing Brodie's Abscess (A). B shows Area of Bone Resected.

CHAPTER IV

ACUTE ARTHRITIS

INFLAMMATION of a joint is called acute or sub-acute according to the virulence of the infection. The infection is carried to the joint :

- (1) By the blood stream (as in septicæmia) ;
- (2) By a wound (as a compound fracture extending into the joint or a bullet wound), or
- (3) By spread from a neighbouring infected area (as in osteomyelitis).

The organisms causing the condition are most commonly the streptococcus and staphylococcus, less commonly the pneumococcus and gonococcus, and rarely the organisms of the typhoid group and dysentery. The arthritis produced by rheumatism and tubercle is not considered here.

The condition is always serious, often with regard to life and always with regard to the future efficiency of the joint. Any joint may be affected, and although the danger to life is equally great in children and adults, a more efficient joint is likely to follow an acute arthritis in childhood than in adult life.

Symptoms and Signs.

(1) General condition. There is the onset of an acute illness or, if the condition has arisen secondary to such a condition as osteomyelitis, a severe exacerbation of symptoms may occur. There may be rigors, and the temperature may be raised to 105°, and pulse to 120 or more in a child. The patient may sweat and have a dry tongue, etc. The symptoms will be less severe in the milder type of arthritis such as that due to a slightly infected needle entering the joint.

(2) Pain in the joint or referred in the course of a nerve. Swelling of the joint and distension with fluid.

(3) Stiffness and limitation of movement.

The joint may have large veins over it, and be hot and tender to touch. Every movement may be extremely painful. A leucocytosis of 15,000 and more is usually present, the increase being due to polymorphonuclear leucocytes.

Diagnosis. At times this may be difficult. When it is known that the patient has a septicæmia and acute symptoms arise in the joint, there is little difficulty about the diagnosis. In those cases in which there has been a small puncture wound of the joint, such as by a needle, or when infection has possibly spread from a neighbouring focus into the joint, doubt may arise as to whether the effusion is serous or purulent. If there has been a rise in temperature coincident with the distension of the joint, the joint should be aspirated to ascertain the nature of the fluid. When there is an open wound into the joint associated with a high temperature, there can be little doubt about the infection of the joint.

Some of the cases which give rise to great difficulty in diagnosis are those in which the onset of symptoms is not very severe, particularly when an osteomyelitis, undiagnosed, spreads into a joint. It may be difficult to determine from the clinical signs whether the condition of the joint is due to rheumatism or to tubercle; when they have been excluded it may not be easy to determine that osteomyelitis is present and is the cause of the arthritis. The presence of leucocytosis will indicate the presence of pus in the body, but does not necessarily imply that the swollen joint is infected. The deciding factor must be examination of the joint fluid.

Aspiration. A large-bore needle, such as is used for lumbar puncture, is fixed to a 20 cc. Record syringe and passed into the joint cavity. Any fluid aspirated is transferred into a sterile test-tube, so that the pathologist can inform the surgeon of the organism present and possibly of the extent of the severity of the infection.

If it is necessary to give the patient an anæsthetic to carry out the fixation of the joint, aspiration should be performed under an anæsthetic. However, if there is doubt as to whether any splinting or any operative procedure is required, the joint is aspirated after anæsthetising with novocaine an area of skin the size of a three-penny bit.

This means of diagnosis is easy in certain joints such as the knee and elbow, but in the case of the hip and shoulder an element of doubt may arise as to whether there is fluid in the joint, owing to the difficulty of determining if the needle has entered the joint. In those cases an

exploratory operation may be necessary to determine if acute arthritis is present.

Treatment. The treatment is described most easily if the *knee joint* is taken as an example of the treatment of an acute arthritis. In view of the fact that infection of the knee joint is as frequent as that of any other joint, there is no hesitation in adopting this course.

If the primary focus of infection is present, this should be treated efficiently. If surgical procedures have already been adopted in connection with this focus, it should be further reconsidered and free drainage established. For instance, if the patient has a whitlow or an osteomyelitis in the arm and develops a suppurative arthritis of the knee joint, the whitlow or osteomyelitis should be dressed under an anæsthetic to ensure that adequate drainage is occurring. Likewise if infection has spread from the tibia into the knee joint, adequate drainage of the tibia should be provided. In the case of penetrating wounds (e.g. bullet wounds) primary excision of the wound should be carried out as a preventive measure ; a similar line of treatment should be adopted in wounds such as are caused by machinery and road accidents. The treatment of the joint itself depends on the general condition of the patient and the nature of the fluid in the joint.

Whichever of the following surgical procedures is necessary it should be associated with *fixation of the joint* by means of extension. Skeletal traction should not be employed ; the fixation is best achieved by placing the limb on a Thomas's splint which has been slightly flexed at the knee and by applying to the leg some form of adhesive strapping to which is fixed webbing, and thence by a wooden stirrup and cord to the end of the splint. The objection to skeletal traction in these cases is that an infective osteomyelitis is prone to occur in the bone through which the pin or wire is inserted.

(1) *Aspiration.* This is used for diagnosis as has already been described ; it is of value as a therapeutic measure in cases of sub-acute and mild acute arthritis, such as those occurring after a puncture by a needle, in septicæmia of low grade virulence, and in joints when infection has arisen subsequent to operative procedures on the joint. Unless the patient is very ill, aspiration should be adopted invariably in the early stages of an acute arthritis except when infection is draining into the joint from a neighbouring focus and when there is already an open wound into the joint cavity. Aspiration may be repeated if the condition has improved, such as is shown by a fall in temperature

after each aspiration, but if repetition appears necessary at such a short interval as 48 hours, it is unlikely to relieve the condition.

(2) *Arthrotomy.* Indications for this operation are :

(a) Severe toxæmia due to the arthritis or to the combination of the arthritis with serious intercurrent disease such as diabetes ; these conditions are most often present in elderly people and in cases which have been left untreated for some days.

(b) Failure of aspiration to relieve the condition.

(c) In certain cases of penetrating wounds.

(d) When infection is draining into the joint from a neighbouring focus.

(e) A sudden exacerbation of symptoms and signs.

(f) As a means to diagnosis in certain joints, e.g. hip.

Operation for arthrotomy of the knee joint. Two incisions are made into the knee joint, one each side of the patella in the long axis of the limb. Each incision is three to four inches in length and placed one inch to the inner and outer side of the patella, the lower ends of the incision being further from each other than are the two upper ends. When the skin and subcutaneous tissues have been divided the small vessels are picked up, and the capsule and synovial membrane are divided slightly nearer to the patella than the original line of the skin incision. The contents of the joint are allowed to flow out. Any vessels which require ligating are attended to and a sterile dressing is applied. The limb is then fixed on the splint as has already been described. The dressing is changed every three or four days, but not at more frequent intervals unless there is some particular indication for so doing.

Modification of the incision. If there is a wound over the joint, the incision must be modified so as to enable the wound to be excised. Posterior drainage of the knee joint is not advocated except when an abscess is pointing in or about the popliteal space. If it is necessary to drain the femur or tibia at the same time, these incisions may have to be modified. In the chapter dealing with osteomyelitis, this matter is discussed.

The reader is referred to other books on surgery in deciding the incisions for arthrotomy of other joints. The general rule is that in most joints dependent drainage is described, and whenever possible

the incision is made over the area of greatest swelling and planned so as to avoid vessels, nerves and tendons.

Drainage and Antiseptics. The insertion of rubber or other drainage-tubes into a joint is not advocated. They seldom perform the function of draining the joint after a few hours, and stiff joints are more frequent after the use of drainage-tubes than otherwise. If the edges of the wound will not remain open to allow drainage of the joint, it may be advisable to place rubber tubing or rubber dam down to the synovial

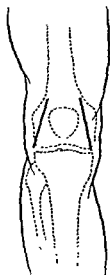


Fig. 1943.—DIAGRAM OF KNEE JOINT SHOWING TWO INCISIONS MADE FOR ARTHROTOMY OF THE KNEE JOINT FOR SUPPURATIVE ARTHRITIS.

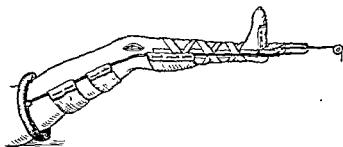


Fig. 1944.—LEMB IN EXTENSION ON A THOMAS'S SPLINT SHOWING ARTHROTOMY WOUND OPEN.

membrane; this should not be necessary in the case of the knee joint, for the planning of the incision should provide for the wound remaining open; if the wound will not remain open at the end of the operation, one stitch is placed to fix the synovial membrane to the edge of the wound and so make the drainage possible. In the case of the hip and shoulder, it is generally necessary to pass a tube down to the joint.

Irrigation of the joint. At the time of operation, irrigation of a joint with antiseptics, whether it be perchloride of mercury, eusol or flavine, is probably of no advantage and may be detrimental to the condition of the joint. Irrigation with saline is only advised when there are large pieces of lymph in the joint which are difficult to remove.

Post-operative treatment of the wound by syringing with antiseptics is of no value. In these cases no advantage seems to follow the use of antiseptic dressings instead of sterile gauze.

In association with the surgical treatment, it is the tendency to employ aids to the patient's power of resistance. Amongst these the most notable are polyvalent anti-streptococcal serum and immuno-transfusion. It is difficult to estimate if these methods of treatment are of value, but no reliance can be placed on the therapeutic effect of injections of antiseptic chemicals into the blood stream.

After-Treatment. When the patient is out of danger and the temperature normal subsequent to arthrotomy, the wounds over the knee tend to heal quickly. The extension should be left on the knee for three weeks after the wound has healed, and no attempt should be made to move the knee during this period, but movements of the ankle and toes should be encouraged. At the end of this time, all the extension apparatus should be removed and the limb cleaned, but the Thomas's splint should still be retained in position. Daily massage for the leg and thigh and faradism to the quadriceps should be commenced. If the patient is well in himself, the splint can be removed in another ten to fourteen days and he can attempt voluntary movement of the knee joint. The patella should be moved from side to side, but no massage should be employed round the joint itself. As soon as he is well enough to get up, weight bearing is encouraged and physical exercises to regain movement in the joint. If the patella seems fixed to the femur or no movement at all appears possible between the femur and tibia, an X-ray photograph should be taken to ascertain if there is bony union.

Results. Septicæmia and pyæmia may cause early death, particularly when the condition is due to a hæmolytic streptococcus. In the rare cases when there is prolonged suppuration from a number of joints the patient may succumb to lardaceous disease.

Children frequently recover full movement after this operation, but the extent of movement which adults obtain varies from none (bony ankylosis) to nearly full movement—which is rare. The joints which remain painful afterwards are those which acquire five or ten degrees of movement. When limited movement persists and there is no bony union, the question arises as to whether manipulation should be carried out to break down the adhesions or whether arthroplasty should be contemplated.

Pathological dislocation is not an uncommon complication to acute arthritis in the hip joint in children, but is uncommon in other joints. Its occurrence is largely due to distension of the joint before adequate splinting is applied.

Amputation of the limb. Unfortunately when the septicæmia is of a severe nature and the patient's power of resistance small, arthrotomy is not successful in relieving the condition. Persistence of a high

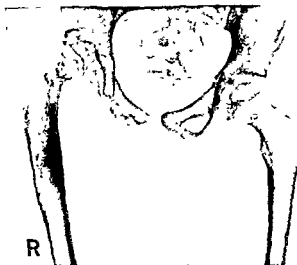


Fig. 1945.—X-RAY SHOWING A PARTIAL PATHOLOGICAL DISLOCATION OF THE HIP JOINT OF A CHILD. THIS IS THE RESULT OF OSTEOMYELITIS OF THE UPPER END OF THE FEMUR AND SUPPURATIVE ARTHRITIS OF THE HIP JOINT.

temperature, rapid pulse, and possibly the development of an abscess elsewhere, may necessitate amputation of the limb. This operation is carried out in cases of suppurative arthritis only as a life-saving measure. It should not be delayed to such an extent that the patient is unable to stand the shock of the operation.

PNEUMOCOCCAL ARTHRITIS

This condition is uncommon and may occur (1) as a primary condition, or (2) as a secondary condition complicating an attack of lobar pneumonia.

(1) As a so-called *primary* condition, it is most frequently seen in children when the source of infection is probably from tonsils or an otorrhœa. An acute or sub-acute arthritis is usually present in the knee joint, but two or more joints may be affected. The physical signs

are those of acute arthritis, and the nature of the infection is discovered by finding the organism in the fluid aspirated from the joint. Although the fluid may be serous and become absorbed, at times the pus is thick and such an acute arthritis usually ends in suppuration. The articular cartilage may not be affected and a movable joint may result.

(2) *Secondary arthritis.* This is usually seen in adults when a large joint is most often affected during the later stages of lobar pneumonia. At times an acute arthritis may occur as part of a general pneumococcal infection. The condition is seldom limited to synovial membrane so that the articular cartilage becomes eroded; the pus is likely to be thick and creamy. The prognosis in this condition is serious.

Treatment. The treatment is that of any other form of acute suppurative arthritis. The condition in children is likely to react to aspiration, but this will not be the case in adults.

ARTHRITIS OF SPECIFIC FEVERS

Scarlet fever. A mild arthritis usually affecting the shoulder or elbow may occur during the first two weeks of this fever. If the joint is put at rest, the effusion is likely to absorb. However, an acute suppurative arthritis, particularly of a large joint, may occur during the illness which presents all the signs and dangers of a streptococcal arthritis. The treatment of this condition does not differ from that of other forms of acute arthritis.

Rare cases are reported of acute arthritis occurring during measles, small-pox and diphtheria.

GONORRHOEAL ARTHRITIS

Arthritis complicating gonorrhœal infection of the urethra or conjunctiva may be: (1) sterile, (2) due to gonococcus, (3) resulting from the gonococcus and other organisms, or (4) due to an infection by the staphylococcus or streptococcus.

The intensity of the condition varies enormously. Four clinical types are usually described:

(a) In the mildest form there are painful joints and ligaments; tenderness about the feet and tenosynovitis are often present.

(b) Sub-acute arthritis of a number of joints which show distension with fluid.

(c) Acute arthritis without suppuration. This condition may be intra- or peri-articular.

The joints affected are generally those which are used most by the patient, so that a stoker is likely to be affected in the arm joints. On the other hand, many joints of the body may show signs of inflammation so that it may be designated a poly-articular arthritis.

Signs and Symptoms. The patient feels ill and has a high temperature. The joints affected are very painful. The skin is hot and red; œdema is often present. The joint is distended and movements limited and painful.

(d) Acute suppurative arthritis may occur which presents the signs and symptoms of any case of suppurative arthritis. The course and treatment of this condition is similar to that of any other case of suppurative arthritis.

Treatment. The general treatment consists in treating the primary infection. The pain is relieved by salicylates, but the drug does not have any effect on the course of the disease.

Local Treatment. When there is an acute suppurative arthritis the joint should be treated by aspiration, arthrotomy if necessary, and splinting as has been described above. If the condition is non-suppurative, immobilisation by splinting is essential while the joint is painful and for two weeks subsequent to the disappearance of acute symptoms. Splinting is then carried on for the night only, but the patient is encouraged to move the joint by day, radiant heat and faradism for the quadriceps being employed. Owing to the formation of adhesions in and around the joints, there is a great tendency to stiffness. Manipulation under anaesthesia should not be employed for at least eight weeks after the cessation of acute symptoms. Manipulation is likely to be of value in those cases in which some voluntary movement has returned. Only a slight increase in movement is aimed at by the first manipulation, and then physical treatment should be continued; if the joint is put through its complete range of normal movement under the anaesthetic, it is likely to become stiff. Subsequent manipulations may be necessary. Manipulation should not be carried out if an X-ray photograph shows destruction of articular cartilage.

CHAPTER V

OPEN OR COMPOUND FRACTURES

INDUSTRIAL and road accidents produce this type of fracture so frequently that adequate knowledge of its treatment is as essential to the general practitioner as it is to the surgeon. The problem of the treatment of the fracture is complicated by a wound extending to the site of the fracture, and often other wounds are present on the limb. Efficient treatment converts the open fracture into a closed or simple fracture at the earliest possible time. Delayed or inefficient treatment may be followed by suppuration of the wound, necrosis of bone at the site of the fracture, formation of sequestra, delayed or complete non-union and often mal-union of the fracture. In addition, the patient has a prolonged and painful illness, during which there is a severe risk of septicaemia or pyaemia arising owing to absorption from the infected wound. Such grave complications necessitate exceptional skill to save the limb and often the patient's life.

Open fractures are almost invariably caused by direct violence, so that the object hitting the limb is usually the cause of dirt or clothing being driven into the wound it produces. A few open fractures occur owing to the end of the broken bone being pushed through the skin.

A classification of open fractures is made for convenience and corresponds approximately to their severity.

- (1) A slit or puncture due to bone.
- (2) Small or moderate laceration associated with comminution of bone.
- (3) Extensive laceration with bone involvement.
- (4) Gunshot wounds of bones.

Pathology. The common organisms gaining entrance to wounds associated with open fractures are the staphylococcus, bacillus coli communis and the anærobic organisms, bacillus Welchii and tetanus bacillus. When the streptococcus is present in this type of wound, it is generally due to secondary infection.

If an open fracture is untreated it may remain clean ; but usually this is not the case. Infection is most prone to occur when a foreign body such as clothing is present in a wound containing a lot of blood clot, particularly if the opening of the wound is plugged up. The plugging up of the wound by clot or foreign body tends to produce gas gangrene, if anærobic organisms are present, whereas if pus-forming organisms multiply, pus is formed and there is a tendency to pocketing. This is frequently followed by prolonged suppuration and necrosis of bone, septicæmia often becoming a complication.

General Treatment. All injuries of bone with laceration of the skin should be treated in a building having good surgical accommodation and an operating theatre.

An anæsthetic should be administered to every patient suffering from an open fracture of a limb bone except in fractures of the fingers and toes, and even these often require it. If the patient is suffering from shock or hæmorrhage, this must be treated before any local treatment is employed. The most valuable treatment for shock is the provision of heat and fluid. The former is provided most efficiently by hot blankets and a radiant heat bath. Fluid is supplied by the application of saline, preferably subcutaneously or by the bowel, and in the more severe cases by blood-transfusion.

If there is doubt as to whether the patient is suffering from shock or not, treatment for shock should be applied. Anti-shock treatment should not take more than two hours. One's aim should be to have the patient ready for the administration of the anæsthetic within six hours from the time of the injury, realising that the sooner the limb is treated the better, but in no way neglecting the treatment of the general condition. With regard to the anæsthetic, gas and oxygen is the ideal ; an anæsthetic of the barbiturate group is not contra-indicated in any but the elderly in this type of injury. Ether is satisfactory, but chloroform should be avoided. As soon as the patient is anæsthetised, anti-tetanic serum is administered.

Special Treatment. Probably the most common of the serious *open fractures* is that of the shaft of the tibia, with which is usually associated a simple fracture of the fibula at about the same level as the fractured tibia or at the neck of the fibula. The treatment of this type of fracture will be described, and any other open fracture can be treated on similar lines.

OPEN FRACTURE OF THE SHAFT OF THE TIBIA

These cases are seen first by doctors when some preliminary *first aid treatment* has been carried out, such as the application of a dressing and splinting, possibly by tying the two legs together. Provided severe shock is not present, the clothing over the leg should be cut up sufficiently to expose the injury.

If the diagnosis is obvious, a dressing should be placed over the wound and lightly fixed on, and the patient removed to the X-ray room with his clothes on. Shock or severe injuries such as a fracture of the skull, or abdominal or chest injuries are the only contra-indication to this procedure.

After antero-posterior and lateral skiagrams are taken, the patient is moved to the ward, where he is prepared for the operating theatre. The clothing should be left on the injured limb. As soon as this is accomplished, he is taken to the operating theatre and anæsthetised. If a portable X-ray apparatus is available, this can be employed in the operating theatre. By this means the patient is saved the journey to the X-ray room and the skiagram can be taken after the patient is anæsthetised, and developed forthwith.

Operative Procedure. Before the operator has washed up, he should cut off and remove all clothing from the limb, together with the first aid dressing.

The limb from the middle of the thigh downwards, including the toes, should be scrubbed with ether soap and a nail brush. The part is shaved and soap removed by a dry swab; the limb is washed with surgical spirit and placed on a sterile towel.

The operator then washes up and cleans the leg and foot again with spirit, and arranges the towels. A gauze swab is placed in the wound to stop the ooze, and this part of the leg is covered with a towel.

An extension pin¹ is put through the os calcis and a stirrup fixed over the ends of the pin. A thin strip of gauze soaked in Friar's balsam is placed round the edge of the pin where it pierces the skin, and a towel is wrapped round the foot.

The *treatment of the wound* is now carried out by the procedure termed "primary excision of the wound." This consists in removal of one third of an inch of skin from around the wound and a similar area of subcutaneous tissue. This should be cut away with any loose tags quickly and deliberately and in one piece. Torn pieces of muscle,

¹ Steinmann's pin or Kirschner's wire.

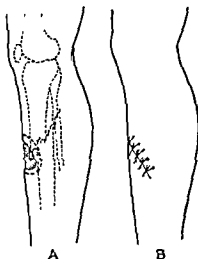


Fig. 1046.—OPEN FRACTURE OF THE TIBIA AND FIBULA. A. SHOWING LINE OF INCISION USED TO EXCISE THE WOUND. B. SHOWS PRIMARY SUTURE COMPLETED.

tags of periosteum, and fragments of bone which are visible in the wound without any periosteal attachment are removed. The wound is cleared of all blood clot, dried, washed out with spirit and then with flavine 1 in 1000. No catgut should be used in the wound unless

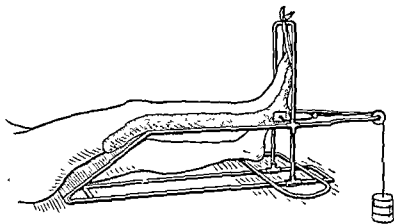


Fig. 1047.—THE LIMB IS SHOWN WITH SKELETAL TRACTION APPLIED THROUGH THE OS CALCIS. A POSTERIOR PLASTER SLAB HAS BEEN APPLIED AND THE LIMB IS RESTING ON FLANNEL SLINGS FIXED TO THE SPLINT.

hæmorrhage is severe. Interrupted silkworm-gut sutures are put through skin and all the tissues that have to be drawn together and tied so that the skin edges are well everted. One stitch every half inch should suffice and every effort should be made to avoid any tension. (For exceptions to closing the wound, see below.) The wound is painted with spirit and a temporary dressing applied and fixed with a bandage.

The limb is now put on the splint. The easiest splint for the patient's comfort and the surgeon's convenience is one of the type usually called a Böhler's splint. A Thomas's splint is equally comfortable and efficient, if it is bent at the knee level and the angle of the ring altered so that it does not press into the groin.

In either case, slings are adjusted and traction applied to a cord fixed to the stirrup. The X-ray is studied and manipulation of the fragments by grasping the limb is carried out whilst the assistant is applying extension by the cord in the line of the limb.

When reduction appears to be as satisfactory as the operator can judge, a 20 lb. weight is tied on to the cord attached to the stirrup. A plaster slab is now made which goes to form a tightly fitting shell for the posterior half of the leg and the sole of the foot.

This is made by taking a six-inch plaster bandage and, after it has soaked in water the necessary time, placing it on a table and unrolling it. It is unrolled so that the strip is equal in length to the distance from above the knee to the point of the heel, and from the point of the heel to the toes with three inches added. The strip of bandage on the table is pulled tight and without cutting the bandage it is further unrolled so that the next piece unrolled covers that already on the table. The remainder of the bandage is carried to and fro until a slab exists six inches wide and the length already indicated; this slab is rubbed so that the muslin and plaster are closely incorporated. It is transferred from the table and placed behind the leg and over the sole of the foot. It should extend quite six inches above the knee joint and the piece protruding beyond the toes is held by the assistant, care being taken that the foot is placed at a right angle with the leg and slightly inverted. The plaster is rubbed so that it fits closely to the limb and an incision into the plaster is made on each side of the heel and the cut edges of the plaster bandage dovetailed in. This plaster shell is bandaged on to the limb or held in position until it has set. It is then trimmed.

Flannel slings are now readjusted on the splint to support the plaster shell and leg in a horizontal position. A cord is passed through a hole made in the plaster where it protrudes beyond the toes and is tied to a bar on the splint.

The temporary dressing is replaced by more gauze and wool and loosely bandaged on round splint and limb. The limb is then X-rayed to see if reduction is satisfactory. Morphia is administered to relieve pain and to keep the limb quiet.

An improvement on this method of "setting the fracture" is

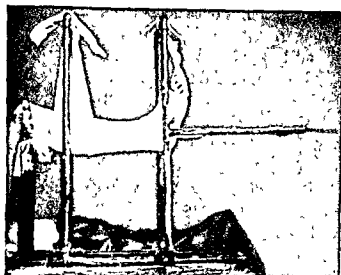


Fig 1950.—FLANNEL HAS BEEN APPLIED ROUND THE PLASTER SLAB AND LIMB, AND PLASTER OVER THIS. PLASTER IS SETTING BEFORE LIMB IS TRANSFERRED TO ANOTHER SPLINT.

(a) If the reduction is satisfactory, little adjustment in the apparatus is necessary during the next few days. A rise in temperature is to be expected and does not necessarily indicate that there is infection in the wound. The dressing is removed in 48 hours, and if the wound is clean and dry, another dressing is applied. If there is tension in the wound, a stitch may be removed, and should there be a collection of fluid, this is let out between two stitch holes before the dressing is applied. The stitches are not removed for ten or fourteen days unless some complication definitely necessitates their removal.

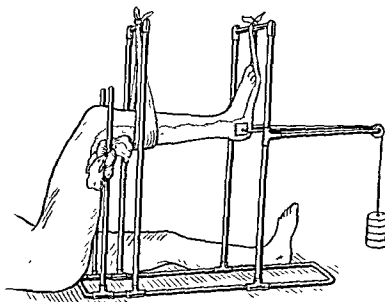


Fig. 1951.—DIAGRAM INDICATING METHOD OF REDUCTION OF FRACTURE BY HEAVY WEIGHT WHICH MAY BE EMPLOYED INSTEAD OF THE SCREW TRACTION.

Three weeks after the application of the extension apparatus the slings are removed from the splint and a domette bandage is placed round the foot and leg; this also encircles the plaster shell. Plaster bandages are applied round the foot and leg in a circular manner and moulded in, leaving an area the size of a pill-box free of plaster casing round each end of the Steinmann's pin. If the limb is large or the fracture in the upper half of the leg, the flannel bandage and plaster should extend half way up the thigh, keeping the knee flexed about 45 degrees. If it is considered necessary to inspect the wound, a window is cut over it. In 24 to 48 hours this plaster should be set hard so that it is safe to remove the Steinmann's pin with extension apparatus. Should any question arise as to displacement of the fragments occurring during this procedure, further X-rays must be taken. The condition can be treated from now onwards as a simple fracture.

(b) Should the X-rays show *slight* displacement, this may be found to be sideways, overlap or separation between the fragments. If there is lateral displacement, the method of correction is the choice between another "setting" under an anæsthetic or an attempt at correction by placing pads and bandages so as to try to press the fractured ends of the bone into better alignment. Overlap or separation of the fragments is corrected by adjustment of the weight.

It is much easier to correct the displacement as soon as the X-ray taken after primary setting is seen, rather than to wait a few days in the hope of the unlikely occurrence of traction correcting it.

(c) If the X-ray shows that the setting is obviously unsatisfactory, it is much wiser to make another attempt straight away rather than to wait twenty-four hours.

DIFFICULTIES AND COMPLICATIONS

Criticism is aimed at both "primary excision of the wound" and closure of the wound. It is considered that this method is suitable for cases which can receive this treatment within eight hours of the injury and under conditions such as enable it to be carried out in a first-class operating theatre. The great advantage is that the fracture is converted into a simple fracture. In certain cases, particularly those which do not come into the hands of the surgeon until ten or twelve hours have elapsed, primary excision of the wound is practised, but the wound is not closed as a primary measure; secondary suture is sometimes possible in these cases. Merely cleansing the edges of the wound without excision is to be condemned as a primary measure in the

treatment of open fractures unless the wound is limited to the size of a tiny puncture.

When open fractures are seen within the hours specified there should be no necessity for the use of Carrel-Dakin irrigation or other antiseptic measures.

The injuries of limbs due to accidents occurring in factories, workshops, and on the road from motor vehicles, are often of such a severe nature that primary excision and closure of the wound cannot be considered when areas of skin and muscle are mutilated; if the joint is opened there should be no attempt at closure of the wound as any operative procedure which produces tension in the injured area is to be avoided. The wound should be dealt with by removing tissue which is unlikely to survive; and by cleansing of the wound and fixation of the limb in some form of splint which will keep the part at rest, control the fracture as far as is practicable under the circumstances, and enable the dressing to be carried out easily by the surgeon and with a small amount of discomfort to the patient. A flavine and paraffin dressing is preferred as this can be left on a number of days and is removed easily.

LATE TREATMENT

The above line of treatment is not always applicable. When shock has been severe or when the patient has other serious injuries, it may not be possible to carry out the procedures already described; further, a number of patients do not reach an institution where the conditions necessary for their application are available. When it is not possible to start treatment of the open fracture for twenty-four hours or more after the injury, *primary excision should not be carried out.*

After the anæsthetic has been administered, the limb is cleansed in the same way and the Steinmann's pin inserted. Any loose tags of skin at the edge of the wound may be cut away. The edge of the wound is cleansed as thoroughly as possible with spirit, blood clot is pressed out, the wound washed out with spirit and flavine and a loose pack of flavine and paraffin inserted. The wound should not be opened up further by any incisions at this time. The limb is then splinted and extension applied as has already been described. The flavine dressings should not be touched for five days unless the limb is uncomfortable, appears excessively swollen, or there is a persistent rise of temperature.

If the infection has been mild, the wound will heal with little formation of pus, but this healing process often takes some weeks.

Should the infection be gross, measures must be taken to compete with the suppuration.

In the primary treatment of open fractures, whether it be within the first twenty-four hours or in two or three days, two methods of treatment should be avoided. The first is the use of "internal fixation," by which is meant the insertion of plates, screws, wire and such-like at the site of the fracture to hold the bone in position. The presence of such foreign bodies and the opening up of new fascial and muscle planes for their insertion is usually sufficient to delay or prevent primary healing of the wound. If infection is really considerable at the time of their insertion it may be followed by such profound suppuration that necrosis is inevitable and the patient's limb and life become endangered. Secondly, it is considered inadvisable to encase a limb entirely in plaster shortly after an open fracture unless ample padding is placed round the limb. Limbs usually swell after this injury so that the circulation is obstructed, and the oozing of the wound, partly due to swelling, makes the plaster dirty. Furthermore, the immediate setting and fixation in plaster of an open fracture seldom ensures the correct alignment of the bones, unless "screw traction" has been employed. Whatever form of splinting is used, it should be borne in mind that sores from pressure by slings and ends of splints occur more frequently in association with open fractures than with simple fractures. They are prevented more easily by a correct procedure at the onset of treatment and by letting well alone subsequently.

Another type of case for consideration is that in which the primary wound treatment and setting has been carried out according to plan, and then it is realised that the bone is not in a satisfactory position, but the patient's general condition or other factors are such that a second attempt at setting the fracture is not considered desirable. It is advisable to leave the limb splinted until the wound is secure. If this heals by first intention, the resetting is carried out usually within three weeks of the accident. This resetting should consist of a manipulation followed by further extension or plaster if the bones will remain in correct position or by an open operation. When an open operation is necessary, an "open reposition" without internal fixation by plate, screws or grafts is desirable, and the limb should be fixed in plaster if possible.

Late Results. In those cases when the wound heals by first intention or quickly with little or no suppuration, and when the bone is set satisfactorily, a perfect limb may result. This is possible in a large proportion of cases.

Delayed union may occur after open fractures owing to mal-union, interposition of soft tissues, or suppuration of the wound.

Non-union is due to the conditions which have been described as causes of delayed union when any one or more are of a severe degree. In addition, separation of the fragments such as occurs from excessive skeletal traction is particularly likely to be followed by non-union.

CHAPTER VI

MUSCLE AND TENDON INJURIES

SUBCUTANEOUS injuries of muscle and tendon may occur from either direct or indirect violence. When direct violence does not lacerate or cut the skin or subcutaneous tissues, the lesion is confined to a tear of muscle and is only complicated in some cases by a hæmatoma.

Indirect violence produces injury to a tendon, muscle or musculo-tendinous junction, by sudden over-stretching; the tear may be complete or completed by a subsequent injury.

Probably degeneration of muscle, such as occurs in enteric fever, or loss of tone of muscle, as occurs in those who are toxic or who have suffered from an acute illness such as influenza, predisposes to muscle injury but not to tendon injury. Arthritis is present in the shoulder joint in some cases of rupture of the long head of the biceps and injury to bone may predispose to rupture of overlying tendon, as is exemplified by rupture of extensor longus pollicis after a Colles' fracture. Occupation may predispose to tears of the origin and insertion of muscles as is shown by injury to the adductors of the thigh in riders and swimmers.

The general condition of the patient is usually below normal when muscle and tendon injuries occur from muscular violence. Possibly owing to lack of fitness, the unconscious reflex of protecting the muscle is slow so that automatic control is somewhat upset.

Undoubtedly injury to these structures occurs more frequently as age advances, but there is lack of evidence that arterial disease, diabetes or alcoholism predisposes to the injury excepting that each may lower the patient's general fitness.

The treatment of these injuries is operative in the majority of cases, but injuries to the extensor longus digitorum at the base of the terminal phalanx are treated by splinting only. The more common lesions are considered separately.

MALLET FINGER

This condition results from an avulsion of the extensor longus digitorum from the base of the terminal phalanx. A flake of bone with

the attached tendon may be torn off from the terminal phalanx. It is produced by indirect violence of varying nature. A cricket ball hitting the end of the finger in a misjudged catch shows that a severe injury may cause the avulsion, whereas nurses and maids may acquire it during the making of a bed, when the trauma appears to be inadequate to tear the tendon. Catching the finger on the edge of a table or on a button, when the last joint is in a partly flexed position, is a not infrequent history. The ring and middle fingers are most often affected.

Clinical picture. Pain and swelling at the end of the finger above the nail are considerable during the first few days after the injury, so that the diagnostic sign of inability to extend the terminal joint may be masked or overlooked. Later, this lack of movement and the permanently dropped terminal phalanx are obvious. Some weeks later the patient may develop an extension of the proximal phalanx. An X-ray is taken to determine whether the injury is :

- (1) A tear of the extensor tendon (X-ray normal).
- (2) An avulsion of a flake of the base of the terminal phalanx, to which the tendon is attached.
- (3) The condition of (2) complicated by a forward dislocation of the terminal phalanx; and
- (4) To exclude a transverse fracture of the second or terminal phalanx with angulation, the only possible error in diagnosis.

Treatment. The best results follow immediate or early treatment by splinting.

If the part is particularly painful, a gas anæsthetic can be administered. A light malleable metal splint is padded with felt and applied to the palmar aspect of the finger and hand, as is shown in figure 1953. The terminal inch and a half of the splint is bent backwards to an angle of 45 degrees, a piece of felt the size of a postage stamp is placed on the back of the terminal interphalangeal joint and a piece of elastoplast, one inch wide, is made to encircle the finger, splint and felt at the site of the injury. This is pulled tight so as to keep the terminal phalanx hyperextended, but not to interfere with the circulation to the pulp of the finger and nail.

The splint is readjusted in three days and then at weekly intervals for a month, after which time a bandage is worn round the finger for a week or so. Massage is of no value and the patient should be instructed

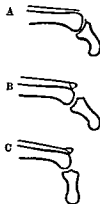


Fig. 1932.—DIAGRAM DEPICTING. A. RUPTURE OF LONG EXTENSOR FROM THE TERMINAL PHALANX. B. FRACTURE OF THE POSTERIOR TUBERCLE OF THE TERMINAL PHALANX. C. CONDITION SIMILAR TO B WITH DISLOCATION FORWARD OF THE TERMINAL PHALANX.

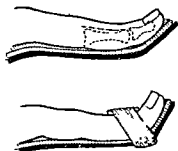


Fig. 1933.—SPLINT ON PALMAR SURFACE OF FINGER SHOWING TERMINAL JOINT HYPEREXTENDED AND FIXED IN POSITION BY PAD AND STRAPPING.

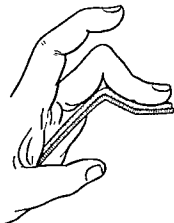


Fig. 1934.—SPLINT ON PALMAR SURFACE OF HAND WITH FINGER FLEXED AT THE FIRST INTERPHALANGEAL JOINT.

that the splint is not to be removed under any circumstances except by the doctor.

This method of splinting is more comfortable and easier to apply than plaster of Paris and is preferable (both for comfort and end result) to fixation of the finger in a position of flexion of the second phalanx and extension of the terminal phalanx in the palm of the hand.

The method of treatment described is suitable when the tendon is torn, or if a flake of bone is broken off. However, should the phalanx be *dislocated* forwards, this displacement must be reduced under an anæsthetic before the splint is applied. The reduction is easy, but it may be difficult to prevent the phalanx slipping forward again. Should it be found that the displacement occurs as soon as the end of the finger is hyperextended, it may stay in place if the terminal phalanx is held straight. When this reduction is undertaken, this should be the primary consideration and the torn tendon secondary. So that if after reduction the ideal splinting position is not obtainable, this can be delayed for forty-eight hours when careful adjustment of the finger and splint should not lead to recurrence of the dislocation.

Results. A large number of fingers treated in this way are normal, so that detailed finger movement such as playing the piano is possible.

A number of cases never regain full extension of the last joint. Most of these cases have not been treated until two or three weeks have elapsed since the injury, but even so there is less of a dropped finger than if no treatment had been applied.

Operative Treatment. The suture of a torn extensor tendon to the terminal phalanx is difficult and the results are usually disappointing. The end of the tendon is ragged and takes a suture badly. No soft tissue remains on the phalanx to which a suture can be fixed satisfactorily, so it is usually necessary to drill this bone from side to side. If operation is undertaken early, good results—sometimes a normal finger—are achieved, but splinting is often equally efficacious.

Definite indication for operation exists, however, for two conditions :

- (1) Unreduced dislocation of the phalanx with a tear of the tendon.
- (2) A painful finger with an un-united tendon some weeks or months after the injury.

The operation of choice is an arthrodesis (fixation) of the terminal interphalangeal joint. This produces a painless finger which does not get in the way and is reasonably strong. Craftsmen and athletes playing games such as cricket and golf benefit by it, but it is not advised in elderly persons.



Fig. 1955.—
INCISION
USED FOR
OPERATION
FOR Mallet
Finger.

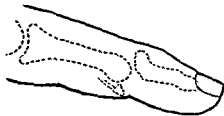


Fig. 1956.—SEPARATION OF ANTERIOR TUBERCLE
OF TERMINAL PHALANX WITH POSTERIOR DISLOCA-
TION OF TERMINAL PHALANX.

Technique. A tourniquet is used. An L-shaped incision is made along the postero-lateral border of the finger, with a transverse incision across the base of the nail. The cartilaginous surfaces are exposed and removed with a small chisel, and shaped so that the terminal phalanx sits on the second phalanx 30 degrees short of a straight finger. The flexor tendon is left *in situ* and if the remains of the extensor tendon

are readily dissected up, an attempt can be made to use them as a posterior covering for the opposed bony surfaces. If there is difficulty in keeping the bones in the required position, a tiny bone peg can be used to fix them.

Immobilisation is essential for six to ten weeks, the exact time depending on when the X-ray shows bony union to be firm.

The reverse injury, in which the flexor tendon is torn off the terminal phalanx, is uncommon, but it is more frequently complicated by a dislocation (in this case backwards) of the terminal phalanx. It is treated on similar lines by splinting, the position of forced flexion being used. Some fibres of the insertion are usually intact, or if a flake of bone is torn off the displacement is usually slight.

TENNIS ELBOW

This condition has been given a multitude of names, chiefly because there has been a divergence of opinion as to the nature of the pathological condition. It would be fitting to group it amongst the occupational diseases and injuries, because it occurs amongst those who use their forearm and hand for a particular purpose such as playing tennis and golf, painting ceilings, etc. There seems little doubt that more than one lesion will produce a painful elbow which is given this popular name. It is convenient to describe the symptoms and signs before discussing the nature of the lesion.

Symptoms and Signs. The patient's complaint is tenderness on the outer side of the elbow and pain on carrying out particular movements. It may be noticed that the pain varies with the position of the arm. It is frequently very persistent and annoying, by being constantly present at times when full use of the arm is particularly required. It may be sufficiently severe to prevent the patient from playing tennis, though more often he finds that he can play, but that one or more strokes are quite impossible. Serving is usually impaired, but back-hand strokes are impossible. In addition to this, in a more severe case there is a sensation of weakness, not only in the elbow, but running down the forearm so that a glass of water or jam jar cannot be lifted up off a table. There may be a tendency to drop articles held in the hand. This condition may last for six months or for years. Examination of the elbow may show fluid in the joint and no other physical signs. This is indicative of a joint condition being responsible for the symptoms and the diagnosis of tennis elbow should not be made. In the typical

tennis elbow there is some fulness below the external epicondyle. There is tenderness over an area which may be only half an inch in diameter; in other cases, the tenderness is just above the external epicondyle or on it. Movements of the joint are normal, and extreme pronation produces no pain. The diagnostic sign is produced by asking the patient to make a fist and hold it tight, and then to palmar-flex the wrist. In the typical cases this produces pain in the area indicated which is relieved by dorsiflexion of the wrist.

Pathology. It is probable that some cases are entirely due to trauma and that others result from the association of trauma with focal infection. The latter produces periostitis of the lower end of the humerus or arthritis of the elbow joint. In addition, there seems to be

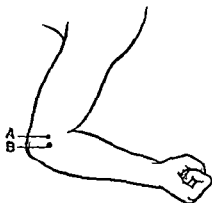


Fig 1937.—TENNIS ELBOW. B IS THE POSITION OF PAIN. A REPRESENTS THE EXTERNAL EPICONDYLE.

no doubt that a tear of the aponeurotic tissue of the extensors from the supra-condylar ridge is the primary lesion in a number of cases and that, if the patient's general condition is not very satisfactory or if there is focal infection, the signs tend to persist. Repeated injury to the radio-humeral capsule may produce symptoms of this nature; possibly, the head of the radius slips out of place from the orbicular ligament on certain movements of the joint.

A small bursa may exist beneath the extensor tendon over the radio-humeral joint; it is probable that this bursa is not constantly present. It has been proved by Osgood that operative removal of this bursa cures a number of cases of tennis elbow.

It seems fair to assume that cases of tennis elbow may be due to tears of muscular attachment and injury to periosteum, to injury to the radio-humeral joint, or to bursitis. In some cases possibly more than one lesion is present.

Treatment. This must be considered according to the length of time the symptoms have been present. Different treatment is employed for the condition in an early stage than for the recurrent or chronic cases. Whichever type of case it is, the first essential of treatment is that the patient should be stopped from playing tennis, using a hammer or carrying out any occupation which is the essential factor in the production of the condition. Secondly, it is most important to eradicate any focal sepsis such as may exist in the teeth or tonsils before treating the local condition.

Treatment of the early stage. This consists in fixation of the arm and support. A small cock-up splint should be worn and two-inch strapping applied over the whole length of the extensors, the lower end of the strapping passing round the hand and end of the cock-up splint. A band of strapping is also placed round the upper part of the forearm just below the elbow joint. The limb is put in a sling. Fixation by this method prevents all but the minimum of movement of the common extensors. This should be carried out for ten days; during that time radiant heat may be of value; diathermy is often ordered, but should only be used round bony points by one experienced in diathermy treatment. Probably radiant heat and diathermy are of little more than psychical value at this stage of the condition. When the strapping is removed, faradism should be employed for the muscles, preferably in a bath. The arm should be kept in a sling for another week, and the patient should not be allowed to play tennis until there is no reaction or return of symptoms, when strong faradic stimulation is employed. Unfortunately, the patient seldom seeks advice during this early stage, and there is no doubt that a number of those who receive benefit by this treatment have a recurrence of symptoms subsequently.

If a *recurrent or chronic case* seeks treatment, few will be cured by the line of treatment already suggested, although undoubtedly some patients are partly relieved by radiant heat, massage and faradism combined with support. Hence this is advised for a few weeks before resorting to a more drastic line of treatment.

Manipulation. It has been found that a number of cases are cured immediately and permanently by a manipulation under an anæsthetic. The patient's forearm, hand and fingers are fully flexed and the forearm pronated. The operator then exerts pressure with his thumb over the site of the pain, i.e. below the external epicondyle, and then forcibly

extends the forearm. The part is then strapped up for two weeks and physical treatment is employed before tennis is commenced.

Operative Treatment. Failure to cure the condition by the methods already suggested leads one to advise operative treatment. Osgood advises that this should be carried out under local analgesia, but most surgeons prefer to do the operation under general anaesthesia. The common extensor is split over the postero-lateral surface of the radio-humeral joint. If a bursa exists in this situation, it will be recognised by the appearance of juicy granulation tissue, and should be removed. If this is not seen, a transverse incision should be made across the

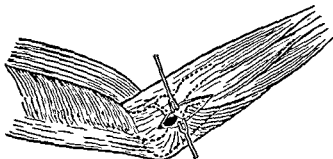


Fig. 1953.—DIAGRAM OF OUTER SIDE OF THE ELBOW JOINT. THE EXPOSURE IS THROUGH THE APONEUROSIS OF THE COMMON EXTENSOR MUSCLES BELOW THE EXTERNAL EPICONDYLE. THE DARK AREA SHOWS THE SITE OF THE BURSA SOMETIMES FOUND AND THE AREA WHERE SYNOVIAL MEMBRANE MAY BE NIPPED.

fascia, but the joint should not be opened unless the capsule and synovial membrane appear to bulge. Should this be the case, it is wise to open the joint and dissect out a portion of synovial membrane. After this has been done, the edges of the synovial membrane are neatly sutured and the joint closed. This procedure is carried out on the assumption that in some cases the synovial membrane may be nipped on extension of the elbow joint. The joint is kept at rest for three weeks. Faradism is employed for a week and then exercises.

RUPTURE OF THE BICEPS TENDON

The only rupture of the biceps tendon which is at all frequent is the rupture of the long head from its origin at the top of the glenoid cavity. Rare cases are reported of rupture of the long tendon in the bicipital groove and at the musculo-tendinous junction. Rupture through the belly of the muscle and separation of the tendon of insertion from the radius are rare injuries.

A rupture of the long head of the biceps is liable to follow a sudden over-stretching, such as may occur in lifting a heavy weight. Possibly it is more frequent when arthritic changes are present in the shoulder joint.

Symptoms. The patient may notice a snap at the time of the injury, followed by pain and weakness of the arm; bruising on the inner side of the arm will occur in some cases.

Examination shows that there is diminution in the power of flexion of the elbow and supination of the forearm, and the bulge produced by contraction of the muscle is nearer the elbow and somewhat rounder than on the normal side. Local tenderness is absent owing to the depth of the tendon.

Treatment. Operative treatment is indicated in patients who are fit during the active years of life. Operative treatment is contra-indicated in cases recognised months after the injury and in those whose life does not necessitate a full efficiency of the arm.

If operation is not advised, radiant heat is employed to relieve bruising, and the patient is informed that the efficiency of the arm is diminished and that operative treatment is not likely to produce full efficiency.

Operative Treatment. An incision is made down the front of the arm over the anterior third of the deltoid muscle. The anterior border of the deltoid is retracted outwards and the bicipital groove is exposed. The tendon of the biceps muscle is searched for; it may be lying in the groove or have retracted and curled itself up in the belly of the muscle.

If the deltoid is very large, it may be advisable to split the muscle at the junction of the middle and anterior thirds. The tendon is freed from blood clot, drawn upwards and laid aside. The short head of the biceps is exposed by a small amount of dissection; an inch below the coracoid process a small incision is made through the tendinous part of the short head from side to side. A pair of Kocher forceps are passed through this button-hole opening and made to grasp the end of the long head. This is drawn through tightly, with the elbow flexed to a right angle, and the end is turned back and stitched to a piece of the long head before it enters the button-hole opening. Two stitches are employed to fix the long head to the short at each side of the opening through the short head.

The wound is closed and the arm fixed to the side, with the forearm

across the chest, by bandages or a light plaster. It is left in this position for six weeks, after which time physical treatment consisting of radiant heat and massage is commenced, and a week later exercises for the muscles are encouraged. An arm with normal efficiency is obtained if an early operation is carried out, although often the belly of the muscle is at a slightly lower level than in a normal arm.

Note. Instead of fixing the long head through the short head, the long head can be fixed to the bicipital groove.

RUPTURE OF THE EXTENSOR LONGUS POLLICIS

Rupture occurs at the level of the lower end of the radius. This injury may occur as an isolated condition or may follow a fracture of the lower end of the radius. In the latter case the rupture takes place, as



Fig. 1959.—THE DOTTED LINE REPRESENTS THE SHAPE OF THE BICEPS MUSCLE WHEN THE LONG HEAD IS RUPTURED.

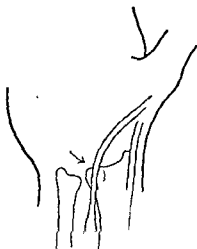


Fig. 1960.—DIAGRAM TO SHOW THE SITE OF RUPTURE OF THE EXTENSOR LONGUS POLLICIS. THE ARROW INDICATES THIS SITE.

a rule, eight or ten weeks after the fracture. It is suggested that the tendon groove on the back of the lower end of the radius is distorted from its normal position and that the tendon and its sheath become adherent and gradually atrophy, so that a small violence is sufficient to produce its rupture.

In cases in which there is no fracture, the history is such as to make one think that the injury has produced a partial rupture and that a few days later complete rupture has occurred; for instance, a woman felt something snap in lifting a dog from the ground, but found the hand

was quite efficient. Brushing her hair a few days later, the wrist suddenly felt weak and she found that she could not extend her thumb.

Examination of the hand shows that the thumb cannot be extended at the last (interphalangeal) joint and that the extensor longus pollicis tendon does not stand out on the radial side of the wrist when an attempt is made to straighten the thumb. Faradic stimulation of the extensor longus pollicis fails to extend the terminal phalanx of the thumb.

Treatment. Operative treatment is indicated except in elderly patients. An incision, four inches long, is made in the line of the tendon, the central point of the incision being the wrist joint. The distal end is isolated and the upper end is searched for. It is generally retracted and may not be easy to find. When the two ends are freed, it will be obvious that an efficient suture is not possible, or if such is possible the line of suture will be in the region of the tubercle of the radius. This is always undesirable. It is necessary to join the two ends by a graft of another tendon. Two inches of the extensor carpi radialis brevis tendon can be cut or an incision can be made on the front of the wrist and a similar length of palmaris longus removed; this strip of tendon is sewn securely to the proximal end of the extensor longus pollicis after one inch or so of this tendon has been trimmed. The free end of the tendon graft is pulled tight and threaded through the normal compartment of the tendon. The assistant hyperextends the thumb while the operator pulls on the end of the tendon still attached to the thumb. This is then stitched to the tendon graft as tightly as possible.

The wound is closed, the thumb being kept in the hyperextended position. A light plaster splint is applied from just below the elbow to beyond the thumb, keeping it in this position.

At the end of two weeks, the plaster is removed and the stitches taken out. A closely-fitting plaster shell is made for the flexor surface of the forearm and the palmar surface of the thumb, still keeping it in a position of hyperextension. Straps and buckles are arranged over the wrist and forearm. These are worn until six weeks have elapsed since the time of operation, after which time the patient is encouraged to move the thumb, and faradism may be of assistance.

RUPTURE OF GASTROCNEMIUS AND TENDO ACHILLIS

The muscular belly of the gastrocnemius is liable to injury from indirect violence. It is produced by a sudden dorsiflexion of the foot,

such as may occur in a quick jump. A small portion of the muscle only is usually torn and this at the lower end of the belly. This occurrence is exemplified by the action of jumping to reach a high ball when playing tennis. The patient may feel something snap and have a pain in the calf. A small irregularity in the outline of the muscle is rarely palpable, but local tenderness and a bruise are found. This condition has often been called rupture of the plantaris muscle, but there appears to be no evidence of injury to this small muscle or its tendon.

The treatment of this condition is to stop all forms of athletic exercise for a month; the calf should be strapped up, but it is unnecessary to fix the ankle and completely immobilise the muscle.

The majority of cases of this injury are not treated in the first place and further tears occur, so that the symptoms become aggravated. No treatment short of that suggested above is likely to produce a permanent cure.

Rupture of the Tendo Achillis is much more serious. It usually occurs in middle life and may result from any force producing a sudden severe dorsiflexion of the foot. The rupture may occur:

- (a) Through its narrowest part about two inches above its insertion into the os calcis.
- (b) At the musculo-tendinous junction.

The rupture may be complete at the time of the injury, or a partial rupture may occur which is converted into a complete rupture by a subsequent injury. It is seldom that the tear of the tendon is a clean cut, for usually tendon bundles break at different levels with ragged ends. The fascia surrounding the tendo Achillis which is not so strong as a true tendon sheath is not necessarily torn at the time of the injury. The divided ends retract and blood clot accumulates around them, the whole area becoming oedematous.

Direct violence, such as a cut from a knife, seldom severs the tendo Achillis, but the author has operated on a girl, whose tendon was divided just above the os calcis by a piece of glass, owing to the bursting of a soda syphon.

Symptoms. A complete tear produces a sudden severe pain as if the back of the leg had been hit. The patient finds he cannot press the foot down in the normal way although he can dorsiflex it. A tender swollen area with bruising develops around the site of the injury.

Diagnosis. If the limb is seen immediately after the injury, it is usually easy to recognise what has occurred. If a day or more elapses before the patient is examined, difficulty may arise in determining if there is a muscle or tendon injury or only a bruise, because the oedema and clot may mask the gap produced at the site of the injury and the plantaris, tibialis posticus and peroneus longus muscles perform a certain amount of the normal function of the gastrocnemius.

A careful examination will show that :

- (a) A greater dorsiflexion of the ankle occurs than on the normal side.
- (b) The belly of the gastrocnemius muscle is at a higher level than on the other side.
- (c) The gap in the tendon can usually be felt and can sometimes be seen in a lateral skiagram.

Not unnaturally one excludes fracture in some of these cases, and provided the X-ray tube is not hard the gap in the soft tissue shadow may be visible.

Treatment. Recent Injuries. In all but elderly patients, operative treatment is advocated for this condition if it is diagnosed soon after the injury. There is no object in waiting beyond the time necessary for an efficient cleansing of the skin.

A tourniquet is applied round the lower third of the thigh after the limb has been exsanguinated. A vertical incision six inches long is made with the centre over the gap. Blood clot is removed from the fascial layers and the ends of the tendon are identified. If the ends of the tendon bundles are very ragged, it may be advisable to trim off loose pieces. With the knee flexed and the ankle plantar-flexed, the ends of the torn tendon are approximated and held together while the assistant straightens the knee and dorsiflexes the ankle to see if this approximation can be maintained. In recent injuries this is usually possible, or is made possible by sliding a portion of the tendon up or down. Suture is made with strong catgut; if the material of the tendon is very friable, suture can be made with fascia lata. It is advisable to approximate the ends of the torn tendon and avoid bridging a gap, even if it be with fascia lata. (The author always aims at suture being made so that the foot can be dorsiflexed to a right angle and the knee extended without undue tension, and considers that if this is not possible it is better to make use of a tendon slide rather than bridge the gap or fix the foot in equinus after suture.)

The fascia and skin are closed, and the leg and foot put into plaster with the foot at a right angle. If there appears to be considerable tension at the line of the suture, the knee may be included in the plaster with flexion at this joint. The plaster is changed at the end of two weeks when the stitches are removed. A new plaster is applied and a walking stirrup fixed in this.

The plaster is discarded in ten weeks from the time of operation, and faradism and massage employed for the calf.

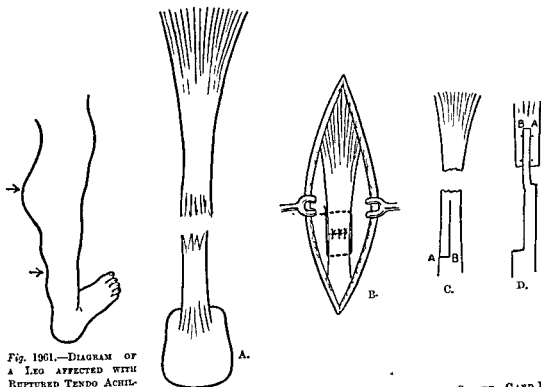


Fig. 1961.—DIAGRAM OF A LEG AFFECTED WITH RUPTURED TENDO ACHILLIS. NOTE THE HIGH CALF MUSCLE AND THE HOLLOW CAUSED BY THE RUPTURE.

Fig. 1962.—A RUPTURED TENDO ACHILLIS. B, METHOD OF SUTURE. C AND D INDICATE ONE METHOD OF SUTURE IF THE ENDS CANNOT BE APPROXIMATED.

Non-operative Treatment may be necessary in recent cases owing to the patient's general condition. Under these circumstances, the foot is fixed in full equinus for eight weeks or longer, so that an opportunity is provided for bridging the gap with fibrous tissue. At the end of this time, physical treatment is employed to strengthen the muscles and to regain dorsiflexion of the ankle.

Old Injuries are represented by such cases as come for treatment some weeks after injury. In elderly patients, physical treatment may be instituted to strengthen the muscles and in an endeavour to enable the uninjured muscles on the back of the leg to perform more plantar-flexion of the ankle than was their custom before the tendo Achillis was

injured. In a middle-aged or younger patient, operation may be considered, but is not followed by so rapid or so successful a result as immediate operative treatment. This is so, because the ragged ends of the torn tendon have acquired adhesion to the surrounding fascia, and are avascular and atrophied. If operative treatment is undertaken, it will be essential to reinforce the suture line by fascia or tendon, such as that of the plantaris. All the ragged ends should be cut off before any suture is attempted. If the gap is considerable, a useful step in the operation may be to turn back half the tendo Achillis so that the necessary length is acquired at the expense of thinning the tendon to half its normal size. Every endeavour should be made to prevent a lengthened calf, i.e. to prevent passive dorsiflexion of the ankle being greater than normal after the operation.

RUPTURE OF RECTUS FEMORIS

The tendinous insertion of the rectus femoris may be torn from the upper surface of the patella by muscular contraction. The accident is comparable to a transverse fracture of the patella. Rarely, an injury occurs at the musculo-tendinous junction in this muscle. The former accident is seldom seen except in elderly patients, although the author has seen one case in a young man who had been in bed for some months owing to injuries of the other limb.

Symptoms and Signs. The knee joint is swollen and painful, and the patient cannot extend the knee although the vastus internus and externus remain intact. A gap of one inch or so can be felt above the patella.

Treatment. Operative treatment is indicated unless the general health of the patient contra-indicates this. If a patient of seventy is fit, the operation is advised, as the disability without operation will be considerable and operation will produce complete restoration of function. A tourniquet is applied, the blood clot removed from the joint and the tendon sutured to the aponeurosis covering the patella.

A light plaster shell is applied on the posterior surface of the limb at the time of operation, and this is worn for six weeks. The quadriceps are treated with faradism as soon as the stitches are removed and gentle active movement is commenced three weeks after the operation, the splint being removed for this to be done. The patient is

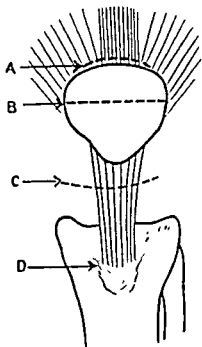


Fig. 1903.—DIAGRAM ILLUSTRATING FOUR INJURIES OF THE EXTENSOR APPARATUS OF THE LEG.

- A. Ruptured quadriceps tendon.
- B. Transverse fracture of patella.
- C. Ruptured ligamentum patellæ.
- D. Avulsion of the tibial tuberosity.

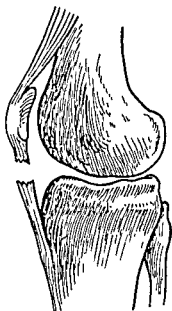


Fig. 1904.—DIAGRAM OF RUPTURED LIGAMENTUM PATELLÆ.

allowed up two weeks after the operation and to walk with a straight knee for a month, after which time the splint is discarded.

When non-operative treatment is advisable, a light plaster shell is applied to the posterior surface of the limb and this is bandaged on, with the knee extended. The patient is measured for a walking apparatus, such as a bucket caliper splint without a joint at the knee. After two weeks in bed the patient is allowed up wearing the splint by day and night for three months.

RUPTURE OF LIGAMENTUM PATELLÆ

The infra-patellar tendon may be torn from the tibia, in which case the knee joint is not necessarily opened, or there may be an injury across the lower part of the knee joint in which the capsule and the tendon are torn transversely about half-way between the lower border of the patella and the tuberosity of the tibia.

Symptoms and Signs. The patient cannot extend the knee and pain is situated below the patella. If the joint is injured it will swell quickly.

The patella is found to be at a higher level than normal and a gap can be felt below it. The X-ray will show that the patella is intact, or one might suspect a fracture of the patella.

Treatment. Operative treatment is indicated and is performed on similar lines to those for rupture of the rectus femoris. If a flake of bone is torn off the tibia, it may be necessary to drill the tibia from side to side, below the site of the injury, in order to fix back into place the lower end of the ligamentum patellæ and the flake of bone.

Early operation produces satisfactory results, but late operation (i.e. some months afterwards) does not produce such an efficient knee, because the patella is difficult to keep down at its normal level owing to contractures around it. If late operation is performed, the ligamentum patellæ should be reconstructed by the use of fascia lata, fixed below through a drill hole in the tibia and sutured above to the strongest portion of the ligamentum patellæ.

CHAPTER VII

PERIPHERAL NERVES

IN the consideration of injuries to a nerve, it is important to appreciate the existence and severity of the lesion from the first examination in order to know what treatment to adopt. As it is not possible to be certain of the existence or extent of section of a nerve from clinical examination immediately after an injury, immediate or early operation on the nerve is seldom carried out, although early operation is the procedure which is followed by the greatest success.

Before resorting to treatment it is essential to be conversant with the clinical and pathological investigations which have been carried out on this subject. The nature of the treatment will depend on the clinical findings and the type of nerve injury found at the time of operation.

General Considerations. These are of a clinical nature, and because the distinguishing features of each group overlap to a certain extent, they are termed symptom-complexes or syndromes.

(A) THE SYNDROME OF INTERRUPTION

This term is used to indicate a complete interruption of the nerve so that no axis cylinder of the upper segment is able to pass into the lower segment. This will be shown by :

(1) *Muscular signs.*

- (a) *Complete paralysis* of all muscles supplied by the nerve below the lesion.
- (b) *Complete loss of tone* in these muscles and by the position of the limb at rest; e.g. wrist drop in musculo-spiral paralysis, equino-varus deformity in external popliteal nerve injury.

- (c) *Absence of pain on pressure of the muscles supplied by the injured nerve ; (possibly such muscular analgesia may persist after the regeneration of the nerve and the return of voluntary movements).*
- (d) *Complete reaction of degeneration in the paralysed muscles.* Normal electrical contraction of the muscle exists for four to six days after the injury, so that the preliminary phase of changes in the reaction of the muscle to electrical stimulation then becomes evident. Considerable information can be obtained by the study of the faradic and galvanic response in all cases of nerve injury.

(2) *Sensory signs.*

- (a) Loss of sensation and absence of any zone of hyperæsthesia in the regions supplied by the injured nerve.
- (b) Absence of pain on pressure applied to the nerve trunk below the lesion.
- (c) Vasomotor and trophic disturbances are present in severe nerve lesions, but it must be appreciated that a vascular lesion may complicate the picture, particularly in injury to the median or great sciatic nerve.

(B) SYNDROMES OF DISSOCIATION

These refer to partial lesions of a nerve, giving rise to incomplete paralysis and alteration in sensation. Obviously, such partial lesions present a variety of signs and give rise to difficulty in diagnosis. The two more common examples of this type of injury are :

- (1) A complete paralysis of a number of muscles (but not the whole group of muscles supplied by the nerve) with changes in sensation which can be termed incomplete.
- (2) The distal muscles are paralysed and there is more or less complete sensory loss, but the proximal muscles remain active.

(C) SYNDROME OF IRRITATION

This indicates a painful condition of a nerve, and is often referred to as *traumatic neuritis* or *causalgia*. A degree of muscular paralysis is

combined with trophic and sensory disturbances. The latter are severe and consist of pain of a burning and often agonising type, hyperæsthesia to such an extent that the patient will not allow the hand or foot to be touched, and tenderness of the trunk of the nerve. Contractures, cyanosis of the hand or foot and altered nails are usually present. The condition is rare, and usually occurs as the result of injuries to the median and sciatic nerves. The lesion may be at any point in the course of the nerve, so that it occurs in lesions within inches of the spinal cord and in lesions which one terms peripheral, such as in the front of the wrist.

(D) SYNDROME OF COMPRESSION

This term is used to indicate that the nerve has suffered in consequence of a lesion of a surrounding structure. Although the phenomena of the syndrome of interruption may be present, the signs are of less severity; pain is usually elicited when pressure is applied to the nerve trunks and muscles, but areas of anæsthesia are unusual.

(E) SYNDROME OF REGENERATION

This may obviously follow any of the previous syndromes. It consists of:

- (1) *Muscular signs* of return to voluntary contraction and of muscular tone. Faradic response will return on electrical stimulus.
- (2) *Sensory symptoms*:
 - (a) Pain radiating along the course of the affected nerve.
 - (b) Pain on pressure on the nerve trunk.
 - (c) Shrinkage of the anæsthetic area.
 - (d) The appearance of paræsthesia.

Tinel's sign indicates an early stage of recovery, and consists in the production of "pins and needles" or tingling by tapping the nerve.

From the point of view of treatment, it is obviously just as important to appreciate these syndromes in the case of a fresh nerve injury as

when it is known that the lesion occurred some months previously. Careful charting of :

- (1) voluntary power of muscles ;
- (2) electrical changes in muscles ; and
- (3) changes in sensation,

is desirable at each examination.

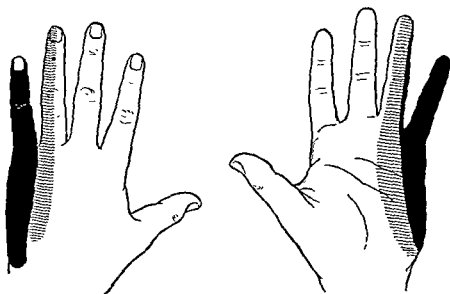


Fig. 1965.—TYPE OF CHART USED TO INDICATE AREAS OF ANÆSTHESIA IN THE HAND. CHANGES IN EPICRITIC AND PROTOPATHIC SENSATION ARE DEPICTED IN A CASE OF ULNAR NERVE PARALYSIS. THE PATIENT'S NAME AND DATE OF EXAMINATION SHOULD BE NOTED ON THE CHART. THE TROPHIC SORES, ETC., CAN BE MARKED IN WHEN PRESENT

PATHOLOGICAL CONSIDERATIONS

Changes in Nerves. When a nerve is completely divided, both of the cut ends retract. A swelling develops on the central end which is usually called a fibroneuroma ; this is formed by proliferation of the sheaths of Schwann and the young axons. The peripheral end becomes tapered or shows a small swelling composed only of the proliferation of the nuclei of the sheath of Schwann. These two swellings may be held together by surrounding structures with fibrous tissue intervening.

If a nerve is partly divided, a smaller degree of separation occurs between the fibres of the divided portion. A notch is visible at the site of the lesion. This may persist or may be replaced by a swelling comparable to the fibroneuroma.

Laceration of a nerve trunk or the introduction of sepsis around the end of the divided nerve produces a considerable inflammatory

Type of Chart used for reference.
INJURY TO ULNAR NERVE.
Level right elbow.

Date of injury, January 1st, 1933.

Date of Examination.	Voluntary power.		Faradic response.		Galvanic response.	
	31.1.33	28.2.33	31.1.33	28.2.33	31.1.33	28.2.33
<i>Muscles</i>						
Flex. Carp. Ul.	-					
Flex. Prof. Dig.	-					
inner half	+		-		sluggish	
outer half	+		+		+	
Flex. Sub. Dig.	+		+		+	
Flex. Carp. Rad.	+		+		+	
Palm. Long.	+		+		+	
<i>Interossei</i>						
palmar	-				sluggish	
dorsal	-		-			
<i>Lumbricales</i>						
outer 2	+					
inner 2	-					
Abd. Min. Dig.	-		-		sluggish	

reaction. When this has subsided, hard scar tissue separates the central and peripheral portions of the nerve. In this type of lesion, an inflammatory condition may spread up the nerve and produce a fibrosis in the connective tissue of the nerve trunk.

When the clinical signs indicate a nerve lesion, but the method of production is by contusion or traction, anatomical continuity of the nerve is not necessarily broken; this produces the syndrome of compression, and the pathological changes are those of degeneration, or later of regeneration of the nerve within an intact nerve sheath. New axis cylinders may find their way through the scar tissue, but more frequently there is little recovery prior to operative interference. The histological appearance of degeneration and regeneration of nerve fibres has been described by many observers, particularly Waller, Pierre Marie, and M. and Mme Déjerine.

Changes in Other Tissues. These are partly trophic changes and partly due to disuse. The muscles waste and fibrosis occurs. Tendons



Fig. 1966.—DIAGRAM INDICATING CHANGES AT THE ENDS OF A NERVE AFTER DIVISION. THE CENTRAL END SHOWS A TYPICAL NEUROFIBROMA, OR NERVE BULB; THE DISTAL END IS REPRESENTED AS EITHER A BULB OR TAPERED END.



Fig. 1967.—DIAGRAM INDICATING A LATERAL NOTCH, SUCH AS MAY BE SEEN IN A PARTIAL LESION OF A LARGE NERVE SUCH AS THE SCIATIC NERVE.



Fig. 1968.—DIAGRAM DEPICTING A COMMINUTED FRACTURE WITH A NERVE STRETCHED ROUND A LARGE LOOSE FRAGMENT. THIS IS SEEN MOST FREQUENTLY IN FRACTURES OF THE MIDDLE THIRD OF THE HUMERUS, WITH STRETCHING OF THE MUSCULO-SPIRAL NERVE AROUND IT.

become adherent to tendon sheaths which become fibrous, as do also the capsules of the joints. The hair, skin and nails grow slowly and irregularly. Probably a number of these changes are the result of irritation from intact sympathetic and sensory axons.

MECHANICAL CONSIDERATIONS

The method of treatment to be adopted depends to a considerable extent on the nature of the injury to the limb.

- (1) *An open wound of a nerve may be* (a) aseptic, or
(b) septic.

The latter may delay or prevent regeneration.

- (2) *A closed wound or subcutaneous injury may be of the nature of* (a) contusion, } both due to injury ;
(b) laceration, }
(c) compression or friction resulting from tumours or aneurysm, or associated with fractures. In the last instance the nerve may be stretched, cut or pressed on by a piece of bone or callus (fig. 1968) ;
(d) traction, such as Erb's birth palsy and injuries to the brachial plexus in accidents.

- Open or subcutaneous injuries may be (1) complete, or
(2) partial.

It is often of value, when a nerve lesion is seen at a time other than immediately after the injury, to note if the injury to the nerve was recognised *at the time of the injury* or subsequently.

TREATMENT

Indications for operation—Types of operation—Splinting—Physiotherapy.

Before proceeding to the treatment, it is important to determine into which syndrome the case falls and which type of mechanical injury has produced the condition. Next, every effort should be made to locate the exact situation of the lesion and to determine the type of

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Indications for operation—Types of operation—Splinting—Physiotherapy.

Before proceeding to the treatment, it is important to determine into which syndrome the case falls and which type of mechanical injury has produced the condition. Next, every effort should be made to locate the exact situation of the lesion and to determine the type of

injury to the nerve which may be present. When surgical treatment is considered advisable, it is important to decide *when* to carry out the operation.

If the clinical signs are such that operative interference is advisable, the treatment consists in:

- (1) Operative treatment.
- (2) Splinting.
- (3) Physio-therapeutic measures.

OPERATIVE TREATMENT

The term "primary suture of a nerve" is employed if operation is carried out immediately after the injury or within a week or two, whereas delayed or secondary exploration of the nerve indicates that operation is carried out after the wound has healed or at some late date after the subcutaneous injury. The primary operation is suitable when the injury is produced by sharp instruments such as a knife or pieces of glass, and operation can be carried out shortly after the injury. In septic wounds, or those associated with injury to a large number of tendons, primary suture is usually inadvisable, but the nerve is exposed and sutured shortly after the original wound has healed. In a case of this type, the treatment of the wound is of paramount importance, so as to obtain rapid healing and thus make it possible to operate on the nerve with little delay.

The various operations which are possible are:

- (a) Suture (primary or delayed).
- (b) Neurolysis.
- (c) Nerve transposition.
- (d) Nerve anastomosis.
- (e) Nerve grafting.
- (f) Avulsion.
- (g) Nerve stretching.
- (h) Nerve injection.

The principal features of each of these methods of treatment will be discussed, but further reference is made to a number of them in the description of operations on individual nerves. The general principles of a nerve operation will be described first, as it is essential to understand these before proceeding to operations performed less frequently and usually under conditions of greater difficulty.

Exploration with view to Suture. When possible a tourniquet is used for operations on the limbs, a pneumatic one for the arm and a thick rubber bandage for the lower limb. The advantage of this is that the operative field is bloodless, small nerves can be detected easily, and vessels clamped without the possibility of injury to nerves. The disadvantage suggested by many surgeons is that after removal of the tourniquet bleeding is more likely to occur at and around the line of nerve suture. It is considered that the advantage of a tourniquet overcomes the possibility of the disadvantages, provided that it is not removed until the dressing is applied, and that this should consist of a single layer of gauze covered by a large quantity of good quality wool, bandaged on firmly in layers.

(1) *Skin Incision.* This is over the line of the nerve except in the region of a joint, when a flap is often employed to advantage. The incision should be of sufficient length to expose at least two inches of the nerve above and below the site of the lesion. It is often advisable to expose four inches above and below the site of the lesion.

(2) *The nerve is exposed above and below the site of the lesion.* This is usually possible by separating muscles. The nerve should not be picked up with any metal instrument but the surrounding structures be freed from it. When one inch has been exposed, a glass rod, with the end of it bent into a semicircle, is passed round the nerve and held gently by an assistant. The dissection is continued down to the site of the lesion. The nerve is then exposed distal to the lesion and treated in a similar manner to the proximal portion. It is now possible to see where the nerve enters and leaves the injured portion. The structures around the neuroma or injured portion are separated. Dissection should always err on the side of leaving more scar tissue on the nerve than appears to belong to it. When the site of the lesion has been freed, a length of five or six inches of nerve is usually free and probably a number of branches passing from it are visible. Two glass rods are passed underneath the nerve to separate it from the surrounding structures.

(3) *Electrical Stimulation.* This is carried out in all delayed operations, and it may be wise to employ it after exposure of the nerve trunk and before exposure of the lesion in cases where the scar tissue is very extensive and dense, such as occurs in association with gunshot wounds. It is not usually employed when immediate suture is carried out, nor is it necessary when a neuroma exists at the end of both the proximal and distal segments, when these are separated.

A faradic current is used. One electrode is placed in contact with the patient's body (e.g. the back). The other electrode consists of a sterilised zinc rod, 10 inches long, to which is attached a wire concealed by a sterile towel. The operator holds the sterile rod and, after finding the current necessary to produce muscle contraction, applies it to the nerve. Muscles reacting can be seen readily if the distal portion of the limb is exposed. If the nerve injury has existed two or three weeks

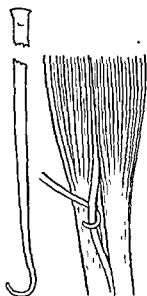


Fig. 1909.

DIAGRAM OF GLASS ROD, SHOWING HOW IT IS USED TO GUARD OR EXTRACT A NERVE DURING OPERATION.

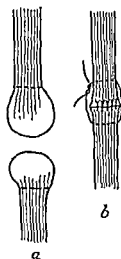


Fig. 1970.

(a) SHOWS PROXIMAL AND PERIPHERAL NERVE BULBS. IT IS NECESSARY TO RESECT THE BULBS AS FAR BACK AS DOTTED LINES BEFORE GOOD NERVE TISSUE IS EXPOSED.

(b) SHOWS SUTURE OF NERVE. THE TEMPORARY STITCH IS SHOWN TIED LOOSELY; FIVE STITCHES THROUGH THE NERVE SHEATH ARE SHOWN.

or more, contraction of a muscle confirms that impulses are being carried through intact nerve fibres. Failure to respond indicates that impulses are not being carried through the nerve fibres and that the latter are separated or degenerated or both. However, a misleading response may sometimes occur, in that muscles may contract when the nerve is stimulated directly, although the syndrome of interruption is present; this occurs in a few cases, months after the primary injury.

(4) *Treatment of the Lesion.* The operator has to decide what type of operation is necessary on the nerve.

End-to-end suture is advisable when the syndrome of interruption exists and (a) when complete separation of the two ends of the nerve is visible in the wound ;

(b) when complete separation of the nerves is present and there is a nerve bulb on either or both ends ;

(c) when a spindle-shaped neuroma joins the proximal and distal segments and electrical stimulation produces no response in the muscles ;

(d) when recovery has not occurred after other types of operation in subcutaneous injuries to nerves, e.g. the musculo-spiral nerve may have been freed from a fragment of bone, but no recovery has occurred in the nerve during the six months subsequent to the freeing operation.

Suture of half a large nerve is possible at times, particularly when, on exposure of the nerve, a notch or a lateral neuroma is visible beside normal nerve bundles.

Before proceeding to operate on the nerve, ligatures should be applied to the vessels so as to get rid of the Spencer Wells forceps. A *new bed* for the nerve should also be prepared so that the line of suture will rest in muscular tissue or fat, and not in scar tissue or aponeurosis or against bone, but it should be appreciated that no tissue should be removed and wrapped directly round the line of suture as this is likely to become fibrotic scar tissue which is harmful round the line of suture.

METHOD OF SUTURE

(a) *Primary Suture.* A temporary stitch of fine catgut is passed by means of a fine round-bodied needle through the sheath and nerve of the central and peripheral nerve ends at a distance of slightly less than half an inch from each extremity. The ends of the nerve are then inspected and if they appear bruised, torn or irregular, fresh surfaces are made by removing about two millimetres of the extremity of each, with a Bard Parker knife or safety razor blade. The temporary stitch is then loosely tied so that the nerve ends are approximated. The nerve sheath is then picked up with very fine-toothed forceps and the sheath of each extremity is sutured with plain catgut (00000) by means of a small round-bodied needle ; the needle and gut should only pass

through the sheath, and for a nerve the size of the median about six stitches are necessary (fig. 1970). The needles and catgut most suitable for the purpose are of "the end-threaded type." Some surgeons use linen thread (160), but this is less desirable than catgut. The temporary stitch is then removed and the site of suture inspected to see that there is no undue tension and that it rests comfortably in the bed.

Delayed or Secondary Suture. In view of the fact that retraction has probably occurred, and that a certain area of nerve may have to be removed in order to approximate good nerve tissue, it is necessary to mobilise the nerve trunk above and below the lesion for some inches. This is usually possible above the site of the lesion but seldom below.

A temporary suture, similar to that used for immediate suture, is passed through the nerve and sheath, half an inch above and below what appears to be good nerve tissue in the proximal and peripheral ends. With a Bard Parker knife the neuroma is removed from the proximal end. The first incision should not remove the whole neuroma. The end is then inspected, and it is likely that three or four gelatinous-looking areas, each the size of a pin's head, will be visible. A section is made above this until normal nerve tissue is seen. The peripheral end is treated in a similar way, but it usually is unnecessary to remove

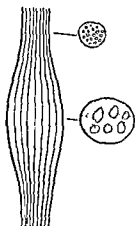


Fig. 1971.

SHOWS A SPINDLE-SHAPED NEUROFIBROMA. THE SMALL DIAGRAM REPRESENTS THE APPEARANCE IN CROSS SECTION AT THE LINE INDICATED. THIS IS NORMAL NERVE TISSUE. THE CROSS SECTION THROUGH THE MIDDLE OF THE SWELLING SHOWS SIX GELATINOUS AREAS OF NERVE TISSUE. BETTER TISSUE THAN THIS IS REQUIRED FOR NERVE SUTURE.

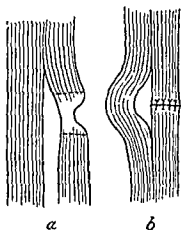


Fig. 1972.

(a) SHOWS A PARTIAL NERVE LESION WITH A LATERAL NOTCH. THE NERVE HAS BEEN SEPARATED, AND THE LINES OF DIVISION ABOVE AND BELOW THE NOTCH ARE INDICATED.
(b) SHOWS SUTURE OF THE NERVE AFTER EXCISION OF THE NOTCH AND THE NECESSARY SHORTENING OF THE AFFECTED PORTION OF THE NERVE.

as much tissue here as from the central end. The divided surfaces are brought together, the temporary stitch tied, and fine stitches applied to the nerve sheath in the manner already described; the temporary stitch is then removed.

When it is necessary to excise a lateral neuroma or lateral notch, the affected area of the nerve is neatly separated from the normal tissue, and dealt with on similar lines to those already described and exemplified in the diagram (fig. 1972).

It is important that the nerve trunk should not be on the stretch after the suture; hence, tension on the nerve trunk and suture line is relieved by the mobilisation, by transposition as will be described for the ulnar nerve, or by flexion of a joint such as of the elbow in the cases of median nerve suture.

When there has been considerable loss of nerve tissue the two-stage operation may assist in the suture. At the first operation, "approximated suture," the nerve stumps are fixed together by a strong suture without trimming them and the limb is fixed in such a position as will shorten the course of the nerve. After a week the position of the limb is altered so as to stretch the nerve, and after a few weeks' time the wound is reopened and accurate nerve suture is carried out. After dressings have been applied, the limb should be bandaged or splinted so that no movement of the limb is possible which might produce tension on the sutured nerve.

(b) *Neurolysis*. This term is used for the operative procedure of separating a nerve from surrounding scar tissue. It is carried out to some extent in every operation performed for injuries to a nerve. It is indicated particularly in cases of persistent pain which is not of the severity of causalgia, and if the faradic response in the muscles supplied by the nerve is brisk. In cases of paralysis it is not likely to be of any value.

The scar tissue is dissected away from the nerve rather than the nerve from the scar tissue. The surgeon must use his discretion as to the extent of the dissection from the nerve. Longitudinal incision into nerve sheaths is seldom of any value. After the neurolysis it is important that the nerve should be placed in healthy muscle and not in animal membrane, in free grafts of fat, or in fascia.

(c) *Transposition*. This term is used when the course of a nerve is altered by a surgical procedure. This may be carried out either as an accessory method of mobilisation in assisting suture, or to relieve

tension on the injured nerve. It is particularly suitable for the ulnar nerve, and the operation is described subsequently on page 3494.

(d) *Nerve Anastomosis*, or nerve crossing, implies the insertion of the distal end of an injured nerve into the whole or a portion of the central end of a sound nerve. Alternatively, the central and distal ends of an injured nerve are sutured into a sound nerve.

There is proof that nerve anastomosis in animals is physiologically sound, and in man successful to a limited extent. It is applicable in man in cases of paralysis of the 7th cranial nerve—the facial nerve. Anastomosis between the facial nerve and the spinal accessory, hypoglossal and glosso-pharyngeal, have all been carried out. Comparable operations on the brachial plexus have not been followed by encouraging results.

(e) *Nerve Grafting*. This implies the insertion of a portion of nerve between the divided ends of an injured nerve when the interval between the latter is too wide to allow of suture. Portions of sensory nerves from other parts of the human body and from animals have been employed. Large nerve grafts are never followed by satisfactory restoration of function, but short gaps have been grafted with some success. This method of suturing nerves is not advocated. If it is employed, it should only be employed to bridge a short gap, and the cross-section of the nerve used for the graft should equal the cross-section of the injured nerve, if possible.

(f) *Avulsion*. This term is used for the removal of a portion of a nerve by exposing it, clamping it, and applying traction to it, so that a greater length of nerve can be removed than by resection. Avulsion of the phrenic nerve is employed to produce paralysis of the diaphragm. The infra-orbital branch of the trigeminal nerve has been avulsed for neuralgia. The operation for phrenic avulsion is described on page 2127. The operation is not required for injuries to nerves.

(g) *Nerve Stretching*. The operation of stretching a nerve is sometimes employed for spasm or pain; in the case of facial spasm the nerve is exposed and traction made on it so that a paresis is produced. On the other hand, a nerve may be stretched without exposing it, and this is not infrequently employed in cases of persistent sciatica when due to neuritis of the sciatic nerve. It should not be employed during

the acute stages of the condition, and relief of pain is not always obtained subsequent to the nerve being stretched.

When it is noted that a nerve has been bound down in scar tissue for some months subsequent to an injury or suture, but pain is persistent, it is unwise to stretch the nerve under an anæsthetic.

(h) *Nerve Injection.* Injection of alcohol, novocaine, saline or other substances into and around nerves, is employed extensively for pain. For intra-neural injection, 90 per cent alcohol has been used to produce a complete nerve block. This has been limited to sensory nerves, but 60 per cent alcohol is reputed to produce a temporary block in sensory nerve fibres. However, reliance cannot be made on this limitation of the effect of alcohol. Novocaine will produce temporary paralysis for a few hours only.

The injection is indicated in cases of causalgia and is often employed for trigeminal neuralgia. When employed for causalgia, a fine hypodermic needle is passed directly into the nerve trunk and alcohol injected until a white appearance is present for the length of one centimetre.

The site of the injection should be proximal to all points of tenderness along the course of the nerve.

For operations on the *Sympathetic Nervous System* see page 3188.

IRREPARABLE NERVE LESIONS

When it is found that a nerve cannot be repaired by one of the methods already described, or treatment has failed to achieve recovery, other operative procedures are possible which are likely to assist the function of the limb. The outstanding example of this is tendon transplantation. This is particularly serviceable in the cases of failure of recovery of the musculo-spiral nerve. The principles of the operation are the transplantation of the pronator radii teres into the extensor carpi radialis longior and brevior, the flexor carpi radialis into the abductor longus pollicis and extensor primi internodii, and the flexor carpi ulnaris into the extensor communis digitorum and extensor longus pollicis.

Arthrodesis of a joint may assist in the efficiency of a limb in cases of paralysis. This is employed in the foot for flail foot, sometimes in the knee and particularly in the shoulder when abduction of the shoulder is impossible.

SPLINTING

When a group of muscles is paralysed it is of the utmost importance to oppose the ascendancy of the antagonistic muscles and the action of gravity. It is found that appliances which prevent and correct vicious positions at the same time favour motor recovery, largely because the paralysed muscles are prevented from becoming over-stretched. If lengthening of a muscle is allowed to occur during the time of paralysis, the muscle cannot become efficient when it has recovered until it has taken up the "slack."

Appliances should be light, must not compress the tissues, and must fit the limb. They should be easy to put on and take off and simple to clean. During the stage of complete paralysis an apparatus should be worn day and night, even when recovery is advancing satisfactorily. The apparatus should be continued for some weeks and

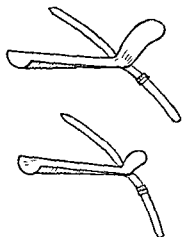


Fig. 1973.—SHOWS TYPES OF SPLINT USED TO SUPPORT THE HAND IN CASES OF M'ULLO SPINAL PARALYSIS. THE UPPER SPLINT IS THE LONG "COCK UP" WHICH SUPPORTS THE WHOLE HAND, WHEREAS THE SMALLER "COCK UP" SUPPORTS THE METACARPUS ONLY. NOTE THE STRAPS FIXED TO THE SPLINT TO KEEP THE WRIST DOWN ON THE SPLINT.

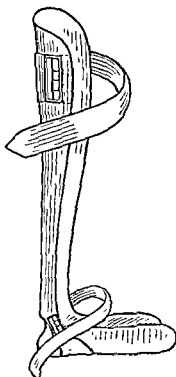


Fig. 1974.—SHOWS TIV SHOE USED FOR DROP FOOT ON THE RIGHT LEG. THERE IS A GUTTER FOR THE LEG AND A FOOTPIECE AT A RIGHT ANGLE TO THE LEG AND A SHOULDER ALONG THE INNER SIDE OF THE FOOTPIECE. THE ESSENTIAL STRAPS ARE FIXED ON TO THE SPLINT.

should still be worn at night after it has been discarded by day. During recovery, a different apparatus may be advisable as it may be wise to adopt one for the new state of the limb. Stock splinting seldom fits sufficiently well to remain in position for twenty-four hours without readjustment. A splint of plaster of Paris can be made to fit accurately, but has a short life. Metal and leather splints can be built to fit the patient.

The appliances most often required are those for musculo-spiral paralysis and in lesions of the external popliteal nerve when it is necessary to overcome wrist-drop and foot-drop respectively. For the former, a "long cock-up" splint made of plaster of Paris or malleable metal is worn day and night. It is important that the strap or turn of bandage round the wrist should hold the wrist right down to the splint. When recovery is occurring, a short cock-up splint is substituted for this. In the case of foot-drop, the patient wears double irons (or inside irons only), which fit into slots in the heel of the boot, an outside T-strap and a toe-elevating spring fixed below to the toe cap of the shoe. At night, a tin shoe is worn which extends from beyond the toes to the top of the calf holding the ankle square and at right angles to the leg. It is important that the strap or bandage should pass over the point of the heel of the splint and over the front of the ankle joint, to hold the heel well down.

The apparatus employed to prevent contracture and to aid recovery due to median, ulnar and internal popliteal nerve injuries, is more complicated and of less value. For paralysis of the abductors of the shoulder, an abduction splint of the "aeroplane pattern," holding the arm in abduction, is essential.

A caliper may be required for certain paralysees of the lower limb.

PHYSIO-THERAPEUTIC MEASURES

Physio-therapy holds the first place in the treatment of nerve lesions. It may be used alone, in association with splinting, or as a complement to surgical treatment. By means of physio-therapy, the muscles are made to contract artificially, their circulation stimulated, and stiffness and deformity of joints prevented; in fact, the measures adopted are such as will keep the tissues in as near a normal, i.e. physiological, condition as is possible. The object of *massage* is to encourage the circulation of blood and lymph, thereby maintaining an efficient supply of blood to the muscle and encouraging the removal of the products of normal muscular activity.

The efficiency of massage is probably greater if it follows radiant heat and forms of bath treatment.

Electro-therapy. In cases of paralysis which are not painful the muscle should be treated by galvanism until there is a response to the faradic current. From that time, faradism should be used as much as possible. If it is difficult to stimulate the affected muscles with faradism owing to the current-provoking movements in antagonistic muscles, galvanism should form the greater part of the treatment. During all electrical treatment the limb should be supported so as to relax the affected muscles: thus in treating musculo-spiral paralysis, the wrist should be dorsiflexed and the fingers and thumb extended. Treatment should be carried out every day for at least a quarter of an hour.

Movements. Active movements are of far greater value than passive movements, and an attempt at active movements should be encouraged from the outset of treatment, even if the muscles are paralysed. For instance, in cases of wrist-drop, the wrist and fingers should be gently supported dorsiflexed, and the patient told to try and hold the wrist and fingers in that position. When slight recovery has taken place he should be aided in these movements. Later, active exercises should replace the electrical treatment, gentle exercises at first and later those requiring more strength, preferably of a nature which is interesting to the patient.

When pain accompanies the paralysis, physio-therapy is more difficult to employ; massage and movement will often increase the pain, but it is found that bath treatment is particularly valuable, and massage under water will often be comforting and of value.

As galvanism stimulates vasomotor activity and exercises a sedative influence, it is used with success in painful paralysis.

All forms of bath treatment have a place in the treatment of various nerve lesions, particularly the painful ones. Diathermy and radio-therapy are seldom used in this country in treatment of these lesions.

PROGNOSIS

Patience is essential on the part of the patient and surgeon in awaiting the ultimate effect of treatment of injured nerves. Firstly, it is frequently advisable to delay operation in the hope that nature

aided by physio-therapy and splinting, will yield a cure. Secondly, the operation may be lengthy and tedious, and great skill be required to achieve a suture which is likely to be successful. Thirdly, many months of treatment may be required after the operation, and there may be no sign of recovery of function or sensation for six months or longer. In the majority of nerve lesions it is impossible to give an accurate prognosis as regards recovery or as to the length of time such recovery will take. Certain facts are known, but exceptions to the more usual occurrences in nerve surgery are frequent. After operation, nerves recover more efficiently when injured at a distance from the spinal cord. Thus, a median nerve injured at the wrist is more likely to recover than if it is injured in the middle of the arm.

Certain nerves invariably recover better than others. The musculo-spiral and external popliteal nerves react to surgical treatment very satisfactorily, whereas the median, ulnar and internal popliteal nerves do not respond to treatment so well. This applies to contusions as well as to complete division of the nerve. Treatment, whether non-operative or operative, is always more effective if commenced soon after the injury than if some weeks or months elapse before this is begun. Although nerves recover if operation, such as suture, is performed many months after the injury, the total recovery is seldom as perfect as if immediate operation had been performed. On the other hand, the musculo-spiral nerve often fulfils a normal function after a greatly delayed suture.

Operations on the brachial and lumbar plexuses are seldom followed by a perfect recovery.

Proximal muscles tend to regain voluntary movement before distal ones. Thus after musculo-spiral paralysis the extensor longus pollicis usually regains power last and, in the leg, the tibialis anticus is the last to recover and may remain permanently weak after paralysis of the external popliteal nerve.

It is estimated that the regeneration of nerve tissue occurs at the rate of one inch per month. This rate of recovery is undoubtedly variable, and motor nerves possibly recover quicker than sensory. Further, some nerves which are divided and sutured within forty-eight hours, i.e. before degeneration has proceeded, recover quickly.

When an incomplete nerve lesion exists owing to contusion or blood clot in the sheath, recovery may commence quickly and continue, whereas when a partial lesion is present, owing to section of a portion of the nerve, recovery will not occur without surgical intervention.

When causalgia is present, it is impossible to foretell when and whether the pain will subside, and whether muscles will recover if motor paralysis is associated. Consequently, a very guarded prognosis should be given when any operative procedure is advised for this condition.

OPERATIONS ON PERIPHERAL NERVES

THE BRACHIAL PLEXUS

Operations on the brachial plexus may be undertaken for a variety of causes and are usually, in the first place, in the nature of an exploration because operative measures on the nerve trunks are not followed by results as satisfactory as those on peripheral nerves. Although ancillary methods to diagnosis may make it possible to state the exact site of the lesion, it is impossible to tell if improvement or cure will result from any operative procedure on the brachial plexus.

Of the many indications for exploration of the plexus, traction injuries are among the more frequent. Traction injury of the plexus of the baby may occur during delivery producing "birth palsy" (usually of the type termed Erb's palsy), and severe traction injuries result from motor and machinery accidents. In both these cases operative interference is usually delayed in the hope that recovery will ensue with physical treatment and splinting. The plexus of infants is now seldom explored, because the few cases that do not recover with efficient treatment are seldom improved by any operation on the plexus owing to the fact that the roots may be torn away from the cord.

Operation may be desirable in a few cases of gunshot wounds. The symptoms arising from "cervical rib" may call for operative treatment, but this is seldom directed to the nerve trunks themselves. The trunks of the plexus may be injured around the shoulder joint as the result of fracture dislocation and fractures of the glenoid or upper end of the humerus. The posterior trunk is most often affected; failure of the nerve to recover necessitates operative exploration.

The exploration of the plexus for traction injuries is made in the posterior triangle of the neck above the clavicle. When it is recognised that an extensive lesion may be found and a large exposure be necessary, it is advisable to divide the clavicle so as to expose the plexus from the axilla to the scalene muscles.

When the operation is carried out for a nerve or trunk injury complicating a lesion of the shoulder joint, an infra-clavicular operation is performed, in the first place at any rate.

Supra-clavicular Operation. Exposure of the brachial plexus in the neck.

The patient is placed on his back with a sand-bag between the shoulders, the head is tilted towards the opposite shoulder and the arm drawn down close to the body.

A flap incision is employed which extends above, from the middle of the posterior border of the sterno-mastoid, downwards along this border to below the clavicle and thence along the lower border of the clavicle to the tip of the coracoid process. If it is necessary to divide the clavicle in the course of the operation, an additional incision is carried downwards over the anterior axillary fold. (An alternate incision is a transverse one from over the clavicular origin of the sterno-mastoid and extending across the posterior triangle at right angles to the nerve trunks. This incision is satisfactory, provided that it is certain the lower portion of the plexus will not require investigation.)

The skin flap and platysma are reflected and the posterior border of the sterno-mastoid defined. The external jugular vein is ligated, the deep fascia divided, and the omo-hyoid retracted or divided if necessary. The nerve trunks are now sought for as they emerge from behind the scalenus anticus. When there is much scar tissue, the nerve trunks may be very adherent to scalenus anticus and scalenus medius, so that dissection will prove difficult. It is necessary to proceed with great care so as not to injure the nerves, such as the phrenic and nerve of Bell, which were probably uninjured prior to the operation. When the trunks have been exposed, the decision must be made as to whether resection and suture is necessary or if the nerve is to be freed and placed in a new bed. In operations on the brachial plexus, resection should be avoided, as suture is always difficult and may not be followed by a successful result. If some nerve fibres are passing through satisfactorily, neurolysis may give a chance to others, whereas resection and suture may sacrifice those that are efficient, certainly for a time.

An outstanding difficulty is often present in that it may be necessary to suture a somewhat fibrosed nerve trunk to a number of distal nerve stumps. When suture is employed in this region, it is advisable to mobilise the nerves distally, to employ a stitch through the nerve as well as the sheath stitches, to suture the nerve with the arm elevated and to keep it in this position for two to three weeks. The platysma and skin are closed with the arm still elevated and the arm kept in this position by plaster of Paris.

When neurolysis is performed on a trunk of the plexus, it is equally advisable to employ some method to ensure that there is no traction on the trunk after the wound is closed. It is far less likely to become adherent to surrounding structures if it is relaxed during the two weeks after the operation. If the wound does not seem quite dry, it is advisable to employ a small drainage-tube for forty-eight hours.

Infra-clavicular Exploration. The patient lies on his back with the arm fully abducted and on a support. The skin incision is a longitudinal one, extending from the junction of the middle and outer third of the clavicle and passing over the coracoid process and along the groove between the deltoid and pectoralis major and thence along the line of the coraco-brachialis. The space between the deltoid and pectoralis major is defined and the muscles are separated so as to expose the tendon of the pectoralis major which is divided from the humerus. There will now be an exposure of the axillary artery and the trunks of the plexus. The dissection should now be commenced in the lower part of the wound by defining the inner border of the coraco-brachialis muscle and tracing up the median nerve. At the top of the wound the pectoralis minor is defined, and if it is obscuring an efficient view of the nerves it should be separated from the coracoid process. It should now be possible to define the median, musculo-spiral and musculo-cutaneous nerves and to trace their origin. This exploration is usually carried out for lesions of the back of the plexus when scar tissue may be holding the musculo-spiral nerve or the posterior cord to the glenoid or to the capsule of the shoulder joint. The difficulty of the operation is complicated by oozing from veins and scar tissue.

If suture is carried out, the wound must be closed with the arm elevated, and at the termination of the operation it should be fixed across the chest to relieve tension on the suture line.

THE MUSCULO-SPIRAL NERVE

Operations on this nerve are required in cases of gunshot wounds and when it is injured as a complication to fractures of the shaft of the humerus. In the latter case, the nerve may be injured by a fragment of bone separated from the shaft, by a sharp projecting fragment of bone, or at times by displacement of the lower fragment of the humerus. Although the nerve may be involved in callus, this is unusual except in comminuted fractures and gunshot wounds, but when callus formation is excessive the nerve may be stretched round it in any type of fracture.

The nerve may be exposed in the lower part of the axilla, in the musculo-spiral groove, and below the groove. The axillary exposure is seldom required, but on those occasions it may be necessary to expose the nerve in the groove at the same time. When the nerve is exposed below the groove, it is usually advisable to extend the incision to see the nerve in part of the groove itself.

Exposure of the nerve below the axilla. The arm is abducted at right angles to the body. An incision is made as for ligation of the third part of the axillary artery in the line of the vessel along the medial border of the coraco-brachialis. The fascia is incised and the lower border of the tendon of latissimus dorsi defined. Starting at the distal end of the wound, the artery and vein are separated, the latter is retracted with the ulnar nerve, whereas the median and musculo-spiral nerves are retracted with the axillary artery. The upper branches of the musculo-spiral supplying the triceps will be seen leaving the musculo-spiral nerve at the lower border of the latissimus dorsi. In the upper part of the wound, the musculo-spiral nerve is best found by retracting the artery, vein and nerve trunks outwards, when the nerve will be seen posteriorly. The superior profunda vessels lie in front of the musculo-spiral nerve on the latissimus dorsi and the dissection is simplified by the ligation of these vessels. If the inner head of the triceps is large and is making the dissection difficult, it is as well to divide some of the fibres.

If this dissection is not sufficient to allow of the necessary operation on the nerve, the arm must be carried across the chest for the exposure of the nerve on the posterior surface of the arm, as is described below.

After suture of the musculo-spiral nerve in the axilla, the arm should be adducted across the chest and fixed in this position so as to relieve tension.

Exposure of the nerve below the musculo-spiral groove. The limb is drawn across the chest, the elbow flexed nearly to a right angle, and the forearm supinated. The skin incision commences above, behind the insertion of the deltoid and two inches above it. It extends downwards and forwards to the antecubital fossa. As it extends forward it crosses the junction of the lower third and the upper two-thirds of a line drawn from the external epicondyle at the lower end of the humerus to the tip of the acromion. The lower end of the incision should be $1\frac{1}{2}$ inches below the elbow joint on the medial side of the supinator

longus. The cephalic vein will be seen in the superficial fascia and should be drawn aside.

It is advisable to expose the nerve first in front of the elbow joint. This is done by dissection between the supinator longus and brachialis anticus. The nerve is found at the level of the lower end of the humerus lying somewhat deeply on the brachialis anticus. Once the nerve is seen in this plane, it is easy to dissect it upwards, care being taken not to injure the branches to the supinator longus.

If the nature of the lesion is such that it is safe to continue the dissection of the nerve upwards, this should be carried out, and as the

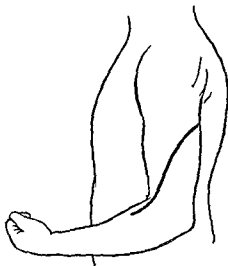


Fig. 1075.—SKIN INCISION EMPLOYED FOR EXPOSURE OF THE MUSCULO SPIRAL NERVE IN THE LOWER HALF OF THE ARM.

level of the triceps is reached the cutaneous branch of the musculo-spiral nerve should be protected. If, however, considerable damage has been done to the nerve, it may be wise to expose the nerve in or just below the musculo-spiral groove and to make a dissection downwards to join that already carried out. In the upper part of the incision, the outer head of the triceps must be divided in the line of and at the level of the groove together with a strong layer of fascia. The nerve lies on the bone below and on the inner side of the superior profunda vessels which appear to be adherent to the sheath of the nerve. As the muscle is retracted, numerous branches will be seen passing to the triceps from the musculo-spiral. Dissection downwards will expose the external cutaneous branch and join the exposure of the nerve previously made.

If the nerve is to be sutured or transferred to a new bed, a flap of

the triceps should be placed between the humerus and the nerve. After closure of the wound, the elbow is fixed in flexion to relieve tension and the hand dorsiflexed to prevent stretching of the paralysed extensor muscles and tendons.

It should be noted that exposure of the nerve in the musculo-spiral groove alone is an unsatisfactory operation, because exposure is difficult and hence the nerve is liable to injury. Mobilisation of the nerve cannot be carried out through so small an incision.

When end-to-end suture is difficult owing to wide separation of the upper and lower ends, or owing to a very long neuroma, there are two means of making the suture more possible :

- (a) anterior transposition ;
- (b) approximated suture followed by a subsequent operation.

(a) The operation of anterior transposition consists in exposing the nerve in the axilla and in front of the arm. The nerve stumps are displaced to the front of the arm, suture being carried out in the tunnel in the brachialis anticus muscle, so that the sutured nerve will pass to the inner side of the arm obliquely downwards and outwards to the outside of the antecubital fossa.

(b) This consists in fixing together the untrimmed nerve stumps with strong catgut under tension, closing the wound and fixing the elbow in full flexion. After a week the elbow is gradually extended. The second operation for suture is carried out in a month or six weeks, when it is usually found that the nerve ends can be approximated after being trimmed.

THE POSTERIOR INTEROSSEOUS NERVE

Operation on this nerve may be required owing to its injury by a sharp cutting instrument such as a carving knife, or owing to injury when operations have been carried out on the upper third of the radius.

Incision. This commences one inch above the elbow joint on the medial border of the supinator longus and is carried down four inches below the elbow joint, the lower part of the incision curving over the extensor muscles in the form of a flap. The superficial veins are

ligated and the medial border of the supinator longus defined and retracted outwards. The nerve is exposed at the top of the wound, and then the aponeurosis between the radial extensors and the extensor communis digitorum is defined and divided in the line of the fibres so as to expose the supinator brevis muscle. It should be possible to define the nerve as it emerges from the lower border of this muscle, care being necessary as the nerve is small. The superficial fibres of the supinator brevis must be divided to expose the trunk of the nerve; this will be simplified if the nerve is seen emerging from the lower border. With a little dissection it should be possible to complete the dissection to join the anterior incision so that the suture can be carried out.

The elbow is flexed after the operation and the wrist dorsiflexed.

It should be noted that the course of the nerve is short and the numerous branches arise immediately below the supinator brevis; care should be taken to avoid injury to these.

THE MEDIAN NERVE

Surgery is required in cases of nerve injury due to penetrating wounds in any part of the course of this nerve. Operations are required most frequently at the level of the elbow joint when the nerve is damaged as a complication of fractures of the lower end of the humerus owing to the lower end of the shaft being displaced forwards. Just above the level of the wrist joint the nerve may be injured in conjunction with the flexor tendons, often by glass or other sharp articles on which the patient has fallen.

Three principal approaches to the nerve are considered, but it may be necessary to expose the nerve over a greater length of its course by joining these incisions. In every exploration it is advisable to commence exposure of the nerve at one of these sites.

(1) *In the arm.* The limb is abducted and somewhat externally rotated and held supported by an assistant. If it rests on a table, the triceps is pushed forwards and confuses the dissection. The incision in the middle of the upper part of the arm corresponds to that used for the exposure of the brachial artery, i.e. along the medial edge of the biceps and five inches in length.

The deep fascia is divided and the biceps defined at the top of the wound and the coraco-brachialis below it. These are retracted outwards and the median nerve is found in front of the artery. In the lower

part of the wound, the median basilic vein is ligated before tracing the nerve downwards under the bicipital fascia.

After the repair of the nerve and closure of the wound the elbow is fixed in a flexed position to relax the nerve.

(2) *At the elbow.* The limb is abducted and the forearm fully supinated and placed on a rest. The skin incision commences three inches above the elbow along the ulnar side of the triceps tendon and is carried downwards to the centre of the antecubital fossa and thence down the centre of the forearm for three or more inches. The median basilic vein is ligated or retracted inwards with the medial cutaneous nerve. The bicipital fascia is divided and dissection commenced at the level of the internal epicondyle, when the nerve is seen on the ulnar side of the brachial artery. As the nerve is traced downwards it is seen to pass between the two heads of the pronator radii teres. The branch to the pronator radii teres is given off above this level and should be demonstrated before dividing the superficial fibres of this muscle to expose the nerve more deeply if necessary.

If the operation is carried out for a lesion associated with a fracture of the lower end of the humerus, a careful dissection of the nerve and transference to a "new bed" by placing muscle between the nerve and humerus is likely to be necessary rather than a suture.

If exposure in the upper third of the forearm is required, the operation described is carried out and then continued by downward dissection, by defining the radial border of the flexor carpi radialis. The nerve will be found deep in the angle between this and the lower border of the pronator radii teres covered by part of the flexor sublimis digitorum. The division of the superficial fibres of the latter muscle aids the dissection.

After closure of the wound the elbow is fixed in flexion.

(3) *At the wrist.* The forearm and hand rest on a table in a supinated position. An incision, four inches in length, is made along the radial border of the tendon of the palmaris longus, extending upwards from the upper edge of the anterior annular ligament, indicated on the skin by the most distal transverse skin crease. The superficial veins are ligated and the space between the palmaris longus and the flexor carpi radialis is defined. The nerve is found under cover of the former tendon or between these two tendons. In old injuries when scar tissue exists, the tendons and nerve may be similar in appearance and care should be exercised in the dissection. It is to

be remembered that the nerve passes deep to the anterior annular ligament. Once the nerve is identified, it can be traced up without much difficulty so that it can be mobilised when suture is required.

If it is necessary to trace the nerve further up the forearm, the incision is prolonged upwards and the nerve followed upwards through the flexor sublimis digitorum muscle. After closure of the wound, tension on the nerve is limited by flexion of the wrist and flexion of the elbow. The latter is not often necessary in a lesion just above the wrist.

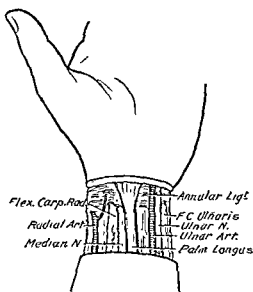


Fig. 1276.—Diagram of the anatomy of the front of the wrist, a common site of injury to median and ulnar nerves.



Fig. 1277.—Skin incision employed to expose the ulnar nerve at the level of the elbow joint. The X indicates the internal epicondyle.

THE ULNAR NERVE

The majority of operations on the ulnar nerve are required for lesions about the elbow joint. Operative interference particularly is required when a fracture of the lower end of the humerus is complicated by ulnar nerve paralysis, when ulnar nerve paralysis arises at some date subsequent to the injury about the elbow joint (this is not infrequently seen at some date subsequent to fractures of the external portion of the lower end of the humerus when cubitus valgus has resulted from the injury), and in cases of recurrent dislocation of the nerve, i.e. when the ulnar nerve slips forwards over the internal epicondyle on flexion of the elbow. Penetrating injuries affect the

nerve most frequently in the lower third of the forearm, but gunshot wounds may injure it anywhere in its course.

It may be necessary to expose the nerve in one of three situations, and as in the case of the median nerve, the dissections so exposed can be united.

The exposure of the nerve in the arm is made by an incision from just above the elbow to just below the anterior axillary fold. This is carried out best with the arm abducted and supported by an assistant. The basilic vein is exposed and the fascia incised just behind it. The median nerve should be exposed in the upper part of the wound where it overlaps the brachial artery. Dissection is now carried out behind this, when the ulnar nerve will be seen lying on the triceps accompanied by the inferior profunda artery. The nerve can be dissected down without difficulty, unless scar tissue is extensive.

The operation on the ulnar nerve at the level of the elbow joint consists in exposing of the nerve above the elbow, at least two inches from the site of the lesion, and tracing it downwards. The position of the arm is important; most surgeons abduct and externally rotate the arm and flex the elbow to eighty degrees, fully supinating the forearm. *The alternative position* is with the limb carried over the chest so that the back of the hand rests on the abdomen with the elbow uppermost. The objection to this position is that it is not easy to keep the arm in this position, the anatomy is reversed, and it is not easy to test the conductivity of the nerve electrically on the operating table.

Incision. The incision commences four inches above the internal epicondyle, is carried downwards in the sulcus behind the internal epicondyle and forwards over the flexor muscles for three inches below the elbow joint. This flap of skin is dissected up, a number of veins requiring ligation. The nerve is exposed in the upper part of the incision on the inner head of the triceps or lying along its medial border. It is traced downwards to the groove behind the internal epicondyle. In this region it is covered superficially by a definite layer of fascia which should be divided along the posterior border of the nerve. The nerve can then be traced forwards into the space between the two heads of origin of the flexor carpi ulnaris. This dissection should be carried out with care so as not to injure the branches to the flexor carpi ulnaris. The upper branch passing to the ulnar head of the flexor carpi ulnaris is shorter than that going to the head arising from the common flexor origin on the humerus.

By this means the course of the ulnar nerve round the elbow is

exposed, and before proceeding to operative measures on the nerve it is advisable to :

- (a) repair the recent fracture (such as internal epicondyle) if the case requires it ;
- (b) prepare a new bed for the nerve.

The latter invariably consists in *anterior transposition* of the nerve. This is advisable : (i) in all cases of suture of the nerve at any level, excepting possibly at the wrist and in the axilla ; (ii) for all lesions of the nerve in the neighbourhood of the internal epicondyle ; (iii) for recurrent dislocation of the ulnar nerve.

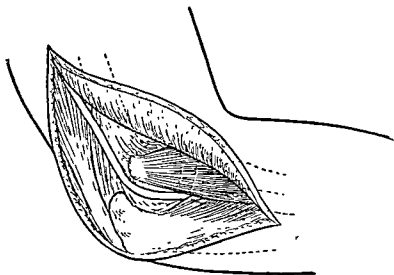


Fig. 1978.—SHOWS THE ULNAR NERVE EXPOSED AT THE ELBOW.

The new bed is formed by cutting the muscular fibres of the flexor carpi ulnaris from the common flexor origin half an inch below the epicondyle. The ulnar nerve is raised by a glass rod from its normal situation by dissecting the sheath from the groove, dividing the articular branch and carefully stripping up the motor branches leaving the nerve below the elbow. It is carried forward into the new bed and the muscle stitched back in position so that the nerve is held forward. Care must be taken that the aponeurosis of the muscles is not lying tightly against the nerve. The wound is closed and the forearm fixed at a right angle to the arm.

The division of the muscle is not necessary if the suture is to be carried out, as a tunnel can be made through the flexor muscles by making an incision half an inch long across the muscles below the

internal epicondyle and by passing an instrument through this hole downwards and inwards to pass into the wound behind the condylar head of the flexor carpi ulnaris. The tunnel is enlarged and the distal segment of the nerve passed through it from below upwards, the elbow being flexed to accomplish this if necessary. Suture of the nerve is then carried out. At the completion of the suture, it will probably be found that the nerve will accommodate itself so that the suture line is in the muscular tunnel.

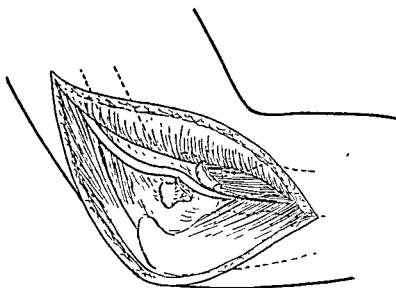


Fig. 1979.—SHOWS A LATER STAGE IN THE OPERATION. THE APONEUROSIS OF THE FLEXOR MUSCLES HAS BEEN DIVIDED AND THE ULNAR NERVE MOVED FORWARDS TO LIE IN ITS NEW BED IN FRONT OF THE EPICONDYLE.

In the lower third of the forearm, the ulnar nerve is exposed by an incision similar to that used for exposure of the ulnar artery. The nerve lies on the medial side of the artery and passes downwards in front of the anterior annular ligament on the radial side of the pisiform bone. After suture of the nerve in this area, the wrist should be flexed and, if any tension exists, there should be no hesitation in extending the dissection upwards and transplanting the nerve to the front of the condyle at the elbow.

GREAT SCIATIC NERVE

Operations on the *great sciatic nerve* are seldom required except for gunshot wounds, as exposure of the nerve for stretching or injections is seldom carried out at the present time. In order to carry out any operative procedure on the sciatic nerve, it is advisable to lay the patient on his face with the thigh fully extended and the knee flexed. Operations

on this nerve usually necessitate an exposure in the buttock and the thigh. An angled skin *incision* is made from below the posterior inferior iliac spine to the lower border of the gluteus maximus to within one inch of the great trochanter. From this point a vertical incision is made down the centre of the thigh, the lower fibres of the gluteus maximus are divided and the muscle split above if necessary. The nerve will be seen lying superficial to the quadratus femoris. It can be traced down deep to the biceps to where it enters the popliteal space. If it is necessary to expose the nerve in the middle of the thigh, the interval between biceps on the lateral side and semitendinosus and semimembranosus must be defined so as to expose the sciatic nerve or its constituents just above the popliteal space. When these muscles are much scarred, the nerve is likely to be bound up in the scar tissue; under such conditions, it is important to expose the nerve above at the level of the great trochanter, and the internal and external popliteal nerves in the popliteal space. After this has been done, dissection is carried up and down to expose the lesion. When the operative procedure on the nerve has been completed, the gluteus maximus is sutured, and the hamstrings brought together with a few stitches in the deep fascia. The skin wound is closed—a matter of some difficulty with the knee flexed. If there is any tension on the nerve, it is advisable for the patient to lie in bed with the hip extended and the knee flexed. This can only be carried out by applying a plaster mould with a large window over the wound. After three days, the patient can lie on his side in the plaster. This is removed in two weeks and the patient gradually allowed to extend the knee.

EXTERNAL POPLITEAL NERVE

It is seldom that operations are required on this nerve. It may be injured by gunshot wounds in any part of its course, and occasionally fractures of the neck of the fibula and open wounds in this region injure the nerve.

In order to expose the nerve, the patient is made to lie on the sound side with the knee and hip flexed and a sand-bag placed under the knee of the affected limb. The skin incision commences four inches above the level of the knee joint along the medial border of the biceps tendon, and extends downwards to the neck of the fibula, at which level it is curved forward over the aponeurosis covering the anterior group of muscles of the leg. The deep fascia is divided over the popliteal space and the biceps tendon defined and retracted outwards;

the nerve is easily traced downwards above the neck of the fibula, the lateral cutaneous branch being protected. The nerve disappears under cover of the peroneus longus as it passes round the neck of the fibula and divides into the anterior tibial and musculo-cutaneous nerves.

Care must be taken at the commencement of the operation not to mistake the edge of the ilio-tibial band for the tendon of the biceps.

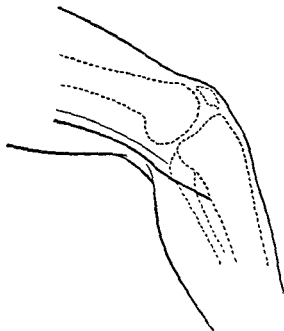


Fig. 1980.—SHOWS THE SKIN INCISION EMPLOYED FOR EXPOSURE OF THE EXTERNAL POPLITEAL NERVE AT THE LEVEL OF THE KNEE JOINT.

Should there be difficulty in suture of the nerve at the level of the neck of the fibula, it is advisable to mobilise the nerve further up the thigh, and the suture line should be protected by turning up a flap of the outer head of the gastrocnemius. The knee must be flexed after closure of the wound so as to prevent tension on the nerve. Subsequently suitable splints are employed to counteract the dropped foot resulting from paralysis of the muscles supplied by the nerve.

Operations on the *Obturator*, *Internal Popliteal* and *Posterior Tibial* nerves are seldom required excepting for the treatment of spastic paralysis.

This part, dealing with "Orthopædics," is continued in Volume III.—EDITOR.

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